CURRICULUM GUIDE

FOR

ELEMENTARY SCHOOL

SCIENCE

Department of Education
Edmonton, Alberta
September, 1969

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NOTE: This curriculum guide is a service publication only. The official statement regarding the course is contained in the Elementary School Program of Studies. The information in the Guide is prescriptive insofar as it duplicates that contained in the Program of Studies. The Guide contains, however, as well as content, methods of developing the concepts, suggestions for using teaching aids and additional reference books.

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AN APPROACH TO THE TEACHING OF SCIENCE

NATURE OF SCIENCE

A modern science program emphasizes inductive modes of inquiry. Contrasted with much science teaching in the elementary school, which has treated science as dogma, the change is marked and radical. In a large sense, the difference stems from one's definition and view of science. In oversimplified terms, if science is regarded as an accumulation of facts about the world, then it is defensible to design curricula with the goal of creating the most efficient scheme for teaching these facts. If, on the other hand, science is regarded as an active process for acquiring knowledge about the world, curricula must be designed to bring the learner into a direct encounter with this process. The substance of inductive inquiry must be data; data and concepts are essential ingredients in inquiry. However, they are not the totality of science; processes of inquiry must be included and balanced against content in importance.

In today's elementary school science program, according to Brandwein (1965, p. 29), "Inquiry is a mix of human activity in search of meaning!" It thus involves the student, no less the teacher, in an active process. Teacher recitation followed by student absorption and feedback are seen to be antithetical to the processes of inquiry given support in this Curriculum Guide. Science is at one and the same time a body of knowledge and a process of inquiry.

OBJECTIVES OF SCIENCE

The new elementary school science program has two fundamental but inseparable objectives. By emphasizing the development and use of inquiry skills as tools of investigation, the program is designed to enable the student to become an active and dynamic investigator of science. To have the student develop basic science concepts is a second aim. A number of concepts, that is abstract ideas generalized from particular experiences, are to be developed under each of the six major conceptual schemes which provide a framework and structure for the program at each grade level.

Objectives

1. *Skills*

   As a result of science instruction, the elementary school pupil should:

   (a) develop the ability to inquire, i.e., ability to think and investigate science through the use of process skills (behaviors) such as observing, classifying, communicating and inferring
   (b) demonstrate manipulative skills in the use of apparatus in order to conduct investigations.

2. *Attitudes*

   Much of the spirit and meaning of science is transmitted to students from the teacher. The teacher must create conditions of learning that will enable the student to:

   (a) demonstrate a growing curiosity and interest
   (b) demonstrate intellectual honesty
   (c) be open-minded
   (d) look for cause-effect relationships
   (e) suspend judgment when data is inadequate.

3. *Concepts*

   As the student proceeds through the elementary school science program, he should develop an increasing body of scientific information in the form of concepts.

Reference:
Brandwein, Paul F. *Substance, Structure, and Style in the Teaching of Science,* Harcourt, Brace, New York, 1965. Essay on Structure and Art of Investigation and the Art of Teaching.

A more detailed discussion of conceptual schemes and process skills is to be found under the section, "Structure of the Curriculum", which follows.

STRUCTURE OF THE CURRICULUM

Structures in terms of this curriculum guide refer to conceptual schemes stated on a high level of generality to concepts and subconcepts and to processes of science stated in specific and detailed terms. The overall structure of the curriculum guide is outlined in terms of conceptual schemes that include key concepts of basic importance. The guide offers a list of six conceptual schemes (generalizations) and twelve basic processes of science to serve as guides for overall planning. Both the products of science (concepts) and processes of science (methods of inquiry) are included.

Conceptual Schemes

A. When energy changes from one form to another, the total amount of energy remains unchanged.
B. When matter changes from one form to another, the total amount of matter remains unchanged.
C. Living things are interdependent with one another and with their environment.
D. A living thing is the product of its heredity and environment.
E. Living things are in constant change.
F. The Universe, and its component bodies, is constantly changing.

Science is not simply a matter of accurate and detailed descriptions of things and events, or of extending our senses by the use of microscopes, telescopes, radar, etc. These are merely steps to a much larger objective: the invention of models or theories which ultimately form the bases for all explanations in science.

Several new elementary school science programs have been based upon conceptual schemes or very generalized theories. The facts and even many of the concepts will need to change with each advance in our understanding of the world. For this reason, it is difficult to forecast with precision what scientific content the child should know. A knowledge of the basic findings of centuries of scientific inquiry gives boundaries and direction to the pupil's active investigation of his world.

Six basic ideas or conceptual schemes where pervading ideas cut across most of the natural science disciplines are part of the structure of the new science program.

The pupil progressing through school should know as much as he can actively seize about each conceptual scheme in terms of his increasing intellectual power. For example, the pupil will progress toward an understanding of the following unifying ideas:

THE CONSERVATION AND TRANSFORMATION OF ENERGY (Conceptual Scheme A); the electromagnetic spectrum, energy of motion and potential energy, electrical energy and chemical energy; force and work, gravitational and magnetic fields.

THE INTERACTION BETWEEN LIVING THINGS AND THEIR ENVIRONMENT (Conceptual Scheme C); animal and human behavior, the relation between biological structure and function, the relationship of structure, color, etc., to the organism's environment and the necessity of the environment providing the conditions for the organism's survival.

Conceptual schemes help us to account for our experiences with nature. The wider their range of application, the stronger is our belief in their validity. This is not to say that conceptual schemes are infallible; they are subject to almost the same uncertainties as any other of man's ideas. But those that persist after being subjected to the test of time, including the repeated challenges and refinements by competent critics, become the foundations or the moorings of science.

A STRUCTURE FOR THE ELEMENTARY SCHOOL SCIENCE CURRICULUM

	CONCEPTUAL SCHEME A Energy may be transformed; it is neither created nor destroyed. (Total sum of matter and energy is conserved: see "Conceptual Scheme B, Concept Level VI".)	CONCEPTUAL SCHEME B Matter may be transformed; in chemical change matter is neither created nor destroyed.	CONCEPTUAL SCHEME C Living things interchange matter and energy with the environment (and with other living things).	CONCEPTUAL SCHEME D A living thing is the product of its heredity and environment.	CONCEPTUAL SCHEME E Living things are in constant change.	CONCEPTUAL SCHEME F The universe is in constant change.
CONCEPT LEVEL VI	Energy obtained from a machine does not exceed the energy put into it.	In nuclear reactions, matter may be destroyed to release energy. (The total sum of matter and energy is conserved: see "Conceptual Scheme A, Concept Level VI".)	Living things are adapted by structure and function to the environment.	The characteristics of a living thing are laid down in a genetic code.	Changes in the genetic code produce changes in living things.	Nuclear reactions produce the radiant energy of stars.
CONCEPT LEVEL V	Once an object is in motion, it tends to remain in motion, unless energy is applied to produce an unbalanced force.	In a reaction, the totality of matter remains constant.	The capture of radiant energy by living things is basic to the maintenance and growth of all living things.	The cell is the unit of structure and function; a living thing develops from a single cell.	Living things have changed over the ages.	Universal gravitation and inertial motion govern the relations of celestial bodies.
CONCEPT LEVEL IV	Molecular motion can be altered by the absorption or release of energy.	Matter consists of elements and compounds.	Living things capture matter from the environment and return it to the environment.	A living thing reproduces itself and develops in a given environment.	The earth is in constant change.	The motion and path of celestial bodies is predictable
CONCEPT LEVEL III	Energy can be changed from one form to another.	Matter exists in small particles.	There are characteristic environments each with their characteristic life.	Plants and animals reproduce their own kind.	Organisms are related through structure.	There are seasonal and annual changes within the solar system.
CONCEPT LEVEL II	There are different forms of energy.	Matter can change its state.	All living things depend on the environment for the conditions of life.	Related living things reproduce in similar ways.	Forms of living things have become extinct.	There are regular movements of the earth and moon.
CONCEPT LEVEL I	Energy must be used to set an object in motion (i.e., when work is done).	Matter exists in various states.	All living things are affected by their environment.	Living things reproduce.	There are different forms of living things.	There are daily changes on earth.

Process Skills (Methods of inquiry)

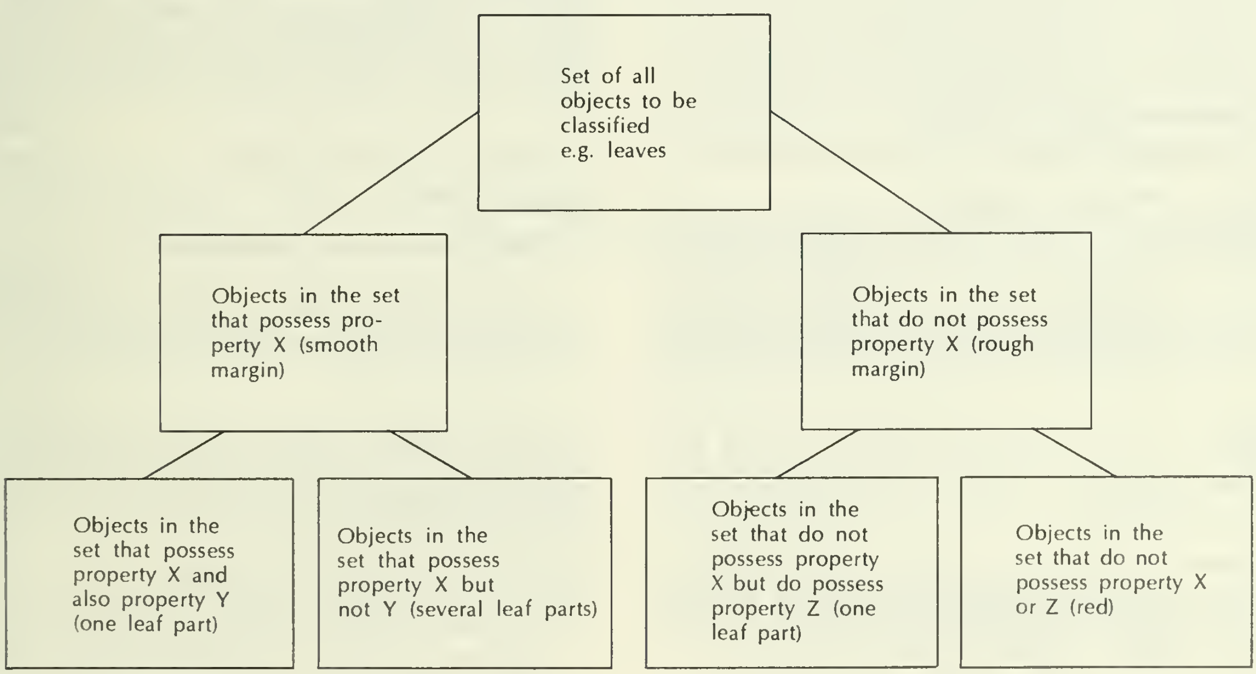
In a new program called SCIENCE: A PROCESS APPROACH (AAA, 1965), processes of investigation have been identified and defined in detail. Each process is believed to be a basic intellectual activity of scientists that can be used in studying content. The proponents of the process approach point out that the content approach leads to an over-emphasis on information, requires too much time and effort, and may fail to develop relationships among concepts. They argue that, instead of being structured around such concepts as force and energy, the program should be built around processes such as observing and measurement, which can be applied to force, energy, matter and a host of other concepts. While this curriculum guide gives recognition to the importance of these processes, it does not emphasize the development of process skills for their own sake. Rather, the process skills should be developed and used as they are required by the student to gain and process data in order to develop concepts. The intent is that the teacher will develop a balanced program where process and content receive equal emphasis.

Basic Processes

Twelve process skills are outlined in the following. Some of these skills or processes are introduced in the early grades and continued in later grades.

Process	**Description of Behavior**	**Example Activities**
Observing	The desired pupil behavior is increasing competence in using not only his sense of sight but also his other senses of hearing, touch, smell and taste.	These may involve both oral and written descriptions of the following: Identify and name colors, textures, relative sizes and other properties of objects. Distinguish differences in temperature, read temperature on a thermometer; identify and name factors in weather such as temperature and precipitation; identify possible causes of change, such as heat, wind and air pressure, show the effect or cause of change on an object such as a balloon; describe selected items so that others can identify and name them; identify and name the main parts of a plant; describe plant growth over a period of time; describe the relationship between two variables.
Classifying	The desired pupil behavior is increasing competence in grouping articles, objects and ideas on the basis of some observable property or properties.	Objects may be classified according to smoothness, texture, color, and special characteristics. Single-stage classifications are followed by two-stage and multi-stage classifications, as shown in the following illustrative sequence.

Two-stage Classification System



Process	Description of Behavior	Example Activities
Quantifying	The desired pupil behavior is increasing competence in measuring length, weight, area, volume, and rate of change of the physical world.	The following are illustrative: Distinguish objects by using such terms as heavier and lighter; identify relative weight by lifting; use a balance to distinguish heavier from lighter objects; use standard units of weight; explain effects of gravitation and inertia; measure the weight of various objects; describe differences in weight; identify, state and demonstrate differences in perception of weight.
Communicating	The desired pupil behavior is increasing competence in describing an experiment so that an individual who has not seen it can carry it out.	Experiences in identifying and naming objects are followed by graphing and describing measured changes as shown in the following example: Identify and name events that can be quantified, such as five bounces of a ball; make a column in a bar graph to represent the frequency of an event; distinguish events shown in a graph; make a bar graph; describe measured changes in speed, temperature, and other properties; make a prediction on the basis of recorded measures; make a graph to show the prediction; describe an experiment so that others might do it.
Inferring	The desired pupil behavior is increasing competence in drawing more than one inference from a set of data, demonstrating that inference can be tested by further observation, and demonstrating that an inference can be tested by applying known tests to the properties of objects. Pupils should indicate that they are able to distinguish between observations and inferences.	The following sequence is illustrative: Use the concept "evaporation" to explain how water is lost by plants; demonstrate a way to measure the water used by a plant; infer and demonstrate that water drawn through plants is transferred to the atmosphere; show that an inference may be tested by additional observations.
Predicting	The desired pupil behavior is increasing competence in conducting experiments to test predictions of relationships between two measurable quantities.	Various tasks might include: plotting data, making and interpreting graphs, and observing from different vantage points. For example, analyze a graph to determine the pattern of relationships (increasing, decreasing, stable); use a graph to predict water loss from plants; make predictions from a series of observations by means of graphs; conduct an experiment to test predictions.

Integrated Processes

Six integrated processes that build upon the basic processes are indicated in the following table:

Process	Description of Behavior	Example Activities
Formulating Hypotheses	The desired pupil behavior involves developing increasing competence in stating a hypothesis regarding causes of a phenomenon or the relationship between two variables. A hypothesis tells how to observe an expected outcome of an experiment.	The following illustrate hypotheses: 1. If the air pressure inside a tube is less than the air pressure outside a tube, then water will rise in the tube. 2. If a ball is dropped, its speed will increase as it approaches the floor.
Making Operational Definitions	The pupil should demonstrate increasing competence in stating the minimum things to do or look for in order to identify the subject being defined.	The following are illustrative: Cold means 15°C for this experiment; little friction means that not more than an additional 10% of force over and above the weight of the object is required to move the object across a surface.
Controlling and Manipulating Variables	The desired pupil behavior is increasing competence in arranging conditions so as to be able to deliberately control and manipulate objects or conditions in an experiment.	The following examples are illustrative: 1. Consider two pendula swinging at different rates. Variables to control might include: the weights (size, shape, and mass), the string (length and thickness), and the length of swing. 2. Metals expand when heated. Variables to control might include: temperature of flame, nature of materials, wind, etc.
Interpreting Data	The desired pupil behavior is increasing competence in getting the most out of data without oversimplifying, drawing conclusions supported by the data, and considering alternative explanations.	Interpretations may be made of observations made in the form of verbal statements, graphs, histograms and tables.

Process	Description of Behavior	Example Activities
Formulating Models	The desired pupil behavior is increasing competence in building both physical and mental models to account for phenomena.	The following models are illustrative: 1. Pictures of the moon's surface 2. Diagrams of the life cycle of an insect 3. Physical model of a chromosome 4. Mental model—idea of an atom.
Experimenting	The desired pupil behavior is increasing competence in planning, conduction and communicating experiments in which the problem is clarified, hypotheses are stated, observations are made, and data is interpreted. This process depends upon the pupil being able to use all of the other processes.	Pupils might develop experiments to answer the following questions: 1. How do mealworms react to light? 2. How many nails can a magnet lift? 3. What happens to salt when it is placed in water? Does more salt dissolve in water at 35°C than at 20°C?

PUPIL EVALUATION

In elementary school science, as in other subjects, the teacher is concerned with how well she is teaching. One measure of her success is the nature and extent of pupil growth toward attainment of the objectives and development in those aspects of science which are being emphasized in the program. To obtain reliable evidence of the nature and rate of this growth on a regular basis, a carefully planned program of evaluation is essential. Such a program can serve a number of specific purposes by assisting the teacher to:

—make wise choices about what to teach and how to teach

—obtain information to diagnose individual pupil's problems

—gather sound evidence for the purpose of decision making in grading and grouping pupils.

The objectives of the present elementary science course must form the basis on which the teacher plans the evaluation of pupil growth. The stated objectives are the development of:

1. Skills—
   a) Process—observing, classifying, communicating, inferring, predicting . . .
   b) Motor—handling apparatus, performing experiments.
2. Attitudes—
   Developing a growing curiosity, being intellectually honest, being open-minded, seeing cause-effect relationships, suspending judgment.
3. Concepts—
   Developing an increasing body of scientific information meaningfully organized around large conceptual schemes.

The only one of these three objectives which has been stressed in the past is that of concepts—a body of scientific information. This objective has been evaluated by pencil and paper tests, either teacher-made or standardized, stressing almost exclusively, recall of memorized information. If the new approach in science is to succeed, a radical change in evaluation procedures is essential.

The evaluation of skills and attitudes can be accomplished effectively through observation and the keeping of anecdoted records. As the teacher observes pupils involved in doing science she can make brief notes concerning how skills and attitudes are developing or changing in individual pupils.

She can also use a checklist similar in format to the one illustrated. The kinds of categories she uses will be her own choice but some of the following seem useful in evaluating skills.

Peter Piper	Willy Nilly	Mary Joyce	
			Observing
			Classifying
			Quantifying
			Communicating
			Inferring
			Predicting
			Formulating hypotheses
			Defining terms
			Controlling variables
			Interpreting data
			Formulating models
			Manipulating equipment
			Performing experiments

The use of such a checklist presumes extensive pupil involvement. If such involvement is lacking, any meaningful use for such a checklist does not exist.

A similar type of checklist can be used in evaluating attitudes. The following categories should be useful as suggestions but are illustrative only.

Peter Piper	Willy Nilly	Mary Joyce	
			Developing curiosity
			Demonstrating intellectual honesty by saying: "I think"
			Admitting mistake
			Admitting he did not know
			Consulting authority
			Demonstrating open mindedness by: changing opinion
			Using more than one source
			Avoiding jumping to conclusions

To evaluate the development of concepts requires a variety of approaches. Some recommended types of tests are:

Objective Tests

Objective tests permit extensive sampling of topics covered and include the short-answer type, the completion type, the true-false type, the multiple choice type and the matching type. They are easily and quickly scored but usually test only recall of factual information.

Essay Tests

While essay tests cannot sample as extensively as objective tests, they have the advantage of providing the opportunity for students to demonstrate the degree to which they can analyze, select relevant information, present evidence and organize answers logically and effectively. The effectiveness of this type of test is increased if the students are required to use knowledge in situations which have not been used in class. Essay items should measure the ability of pupils to apply principles, recognize relationships, and make generalizations.

The Art of Questioning

Teachers can lead students into all kinds of thinking through careful use of high quality questions. While some teachers intuitively ask superior questions, many overemphasize those that require students only to remember ideas rather than to use ideas.

A very useful classification of questions has been developed by B. S. Bloom. By first classifying educational objectives and thinking processes into categories that were meaningful with on-going work of the classroom, Bloom was then able to define categories of questions which were useful to the teacher in teaching and in evaluating. A very brief summary of Bloom's categories of thinking is as follows:

1. Memory:

   The student recalls or recognizes information.

2. Translation:

   The student changes information into a different symbolic form or language.

3. Interpretation:

   The student discovers relationships among facts, generalizations, definitions, values, and skills.

4. Application:

   The student solves a life-like problem that requires the identification of the issue and the selection and use of appropriate generalizations and skills.

5. Analysis:

   The student solves a problem in the light of conscious knowledge of the parts and forms of thinking.

6. Synthesis:

   The student solves a problem that requires original, creative thinking.

7. Evaluation:

   The student makes a judgment of good or bad, right or wrong, according to standards he designates.

The teacher who has learned this taxonomy of questions and applies it can improve the intellectual climate in his classroom. Not only will he realize the importance of each category of question but he will also be seeking opportunities to employ a greater variety of questions in order to develop each student's ability to use all the categories of thinking of which he is capable. It is not enough for a student to be able only to recall information, he should learn to translate, interpret, apply and so on. Only as the result of expert teacher guidance and direction will these higher types of thought processes be encouraged.

References:

Sanders, Norris M., *Classroom Questions, What Kinds?* Fitzhenry and Whiteside Ltd., 1590 Midland Avenue, Scarborough, Ontario.

Bloom, B. S., *Taxonomy of Educational Objectives: Part I The Cognitive Domain,* Longmans Canada Ltd., 55 Barber Greene Road, Don Mills, Ontario.

CONCEPT FORMATION

One great weakness of current science teaching seems to be an almost exclusive reliance on textbooks, the teacher, and other such authoritative sources of information. These sources for science learnings, as they facilitate the development of concepts, are quite important compared to direct physical experiences.

A highly diversified program based heavily on direct physical experiences, but reinforced by the use of films, filmstrips, non-projected materials and discussion, is essential to readiness for most concepts. It is important that experiences with real things be presented within a conceptual framework. Then, and only then, will early learnings form a base for the assimilation of experiences that come later—experiences that may involve either direct observation (using all the senses) or verbal and pictoral reports of observations made by others. Lavatelli, on pointing up the importance of the laboratory approach states:

> Piaget has written of the dangers of premature verbalization; he maintains that the child can receive valuable information via language only if he is in a state to understand the information. In science, direct physical experience, either through demonstration or experimentation, is essential to readiness for most concepts in the curriculum. Furthermore, the learner needs the opportunity for corrective feedback gained in interaction with his peers as well as his teacher. Such experiences of concrete manipulation and interaction with classmates are provided in the laboratory approach.[1]

In performing investigations with new phenomena, the children are confronted with evidence which contradicts what they presently believe. It is through laboratory-type experiences that erroneous concepts can be challenged and the learner readied to acquire new knowledge.

Conceptual Formation

A concept is a gradually developing, never ending verbal and mental image which is unique to each person at any time. Concepts are not taught directly by the teacher, but rather, are the result of mental and physical activity on the part of each student.

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[1]Cecilia B. Lavatelli, *Individualization Through The Laboratory Approach, Science Curriculum Improvement Study Newsletter,* No. 12, p. 1, Spring 1968.

THE ROLE OF THE TEACHER AND THE STUDENT

The inquiry approach will, for some teachers, require a different way of teaching. Their role will shift from that of dispensing facts and information to providing children with opportunities for discovering this knowledge for themselves. It is vital that pupils have many opportunities for active physical and mental exploration with materials and equipment.

In this program, it is important for you as a teacher to encourage your students to question and wonder about things. Allow enough time in your schedule for the children to plan and to carry out investigations and to find answers for themselves. Do not feel pressured to "cover" a great deal of information, but instead, permit the children sufficient time to develop basic science understandings.

A concept can often be introduced by confronting the class with a problem, the solution for which the children have to apply previously learned concepts and process skills. Give the children an opportunity to develop their own theories. When children suggest theories or "guesses" as possible solutions, do not be too quick to indicate whether the suggestions are right or wrong. A possible general teaching strategy might involve the following.

As teacher, you should assume the role of an attentive listener and assist the children to be more self-sufficient. You should expect that your children will make mistakes. When your students make mistakes, help them to analyze where they went wrong and guide them (not tell them) toward a more suitable explanation. Many scientific discoveries are made in laboratories where a spirit of exploration is maintained. Similarly, if a climate of inquiry is carefully nurtured in the classroom, science learnings can be broadened and enriched. In keeping with this spirit, allow extra time for experiments and demonstrations that may not work out on the first try. Be sure to give the children the right to make mistakes—and the time to correct them.

As children work toward finding solutions to their problems not only is it important for them to acquire the products of scientific investigation (the concepts and/or theories), but it is also important for them to use the processes of science. Note that for each suggested activity in this guide certain process skills are emphasized which can be developed only through direct experience.

The discovery approach does not mean that you will allow the whims of the students to guide the science program. You will need to carefully organize much of the instruction. Children should plan some of their own activities, but this should only be done within the overall organization of the science curriculum.

Recently there has been a trend away from teaching science by the problem-solving method. It has been recognized that scientists do not use one exclusive method for solving problems, but instead, use a variety of methods in their scientific work. It has also been recognized that the problems with which children are confronted in a science program can be solved without strict adherence to the five ordered steps of the problem-solving method.

Problems given to pupils by the teacher are often not vital. A problem is real to the pupil when he observes a situation which is in conflict with his existing understandings. From the problem situation the pupil will try to develop a theory or possible explanation. Investigation(s) involving the construction of hypothesis is (are) necessary. The hypothesis developed will be the result of using the information he has acquired from previous experiences.

Hypothesis, correct and incorrect, will come from clear insights and adequate interpretations, but only if children are encouraged to meet the challenge of unconventional learning.

The work of Suchman at the University of Illinois is an excellent verification of the belief that children can prepare and test hypotheses. There is no dearth of opportunity for training in good habits of logical thought if children are not restricted to dull memorization of the textbook. Children should have numerous opportunities to predict the results of a particular action. Do not supply the answer in advance, nor allow children to turn to authority before their own analytical schemes are found wanting or before additional verification is required. Continue to ask, "Why? How do you know? How can we test this? Are you sure? How can we find out? What will happen if we do what you say? What do we need in order to do it? Where can we find out? What do we do next?"

A permissive classroom atmosphere must prevail which encourages both children and teacher to examine the evidence they find, to assess their hypotheses, and to come to the most reasonable and logical interpretations of the data consistent with the evidence.

EXAMPLE: A Strategy for Teaching an Open-ended Problem Situation, Upper Elementary.

CONFRONTATION

In introducing students to the concept, "Energy must be applied to produce an unbalanced force, resulting in motion or a change of motion," a burning piece of paper might be thrust into a milk bottle and then a peeled, hard-boiled egg placed on the mouth of the bottle without comment from the teacher. (The egg, which is larger than the mouth of the bottle, is pushed through the mouth and "pops" into the bottle. This is the confrontation which provides the focus for the investigations which may take two or more periods). This activity may be done as a demonstration by the teacher or by pupils working in groups.

The pupil might make the following recordings in his book:

Observations:

This would include the actual things the pupils saw, not what they assumed happened. For example, the pupil might record "Shortly after the egg had been placed on the mouth of the milk bottle which contained a piece of burning paper the egg began to 'jump'." (It may be necessary to do the activity more than once.)

Theory:

Have the pupils suggest theories to explain the happening. Pupils will suggest various theories as possible explanations. These theories might include the following:

1. The air in the milk bottle expanded when it was heated and some air escaped from the bottle. The air contracted again when it cooled. The contracted air occupied less space, and hence, the greater air pressure on the outside pushed the egg into the bottle.
2. The neck of the bottle expanded and therefore let the egg fall into the bottle.
3. Part of the air was burned out which left the air presure on the outside greater than that on the inside so that the egg was pushed into the bottle.
4. The burning paper dried the egg out, thus making it smaller so that the egg fell into the milk bottle.

Since several possible theories have been developed that may serve as possible explanations, it now becomes necessary for pupils to develop investigations to check their theories. Pupils might then record under the headings given below. An example of possible pupil recordings is also given:

Problem:

What caused the egg to go into the bottle?

Hypothesis

1. If the milk bottle is heated, the diameter of the milk bottle neck will expand and let the egg drop into the bottle. (Students either individually or in groups will need to test each hypothesis that is developed. A method of attack should be planned.)

Attack

Measure the diameter of the milk bottle mouth before and after heating.

Observations

	Temperature	Inside Diameter of Bottle's Mouth
Before Heating	70°F	1.5 in.
After Heating	83°F	1.55 in.

Interpretation of Data

Since the inside diameter of the milk bottle mouth increased, it is possible that this helped to put the egg into the bottle.

EXAMPLE:

A Strategy for Teaching an Open-ended Problem Situation, Lower Elementary.

CONFRONTATION:

By using a magnet, have pupils pick up various objects such as tacks, nails, etc. Then have them attempt to pick up a small piece of aluminum. All metals pupils picked up initially were attracted by the magnet. A confrontation (by means of a discrepant event) is provided when the magnet will not pick up the piece of aluminum. The pupil might record the following:

What I Saw: (Observation)

The magnet picked up the nail, paper clip, and tack but did not pick up the piece of aluminum.

What I Found Out: (My interpretation of what I saw)

A piece of aluminum is not picked up by a magnet.

A GENERAL TEACHING STRATEGY

TERMS:

CONFRONTATION:

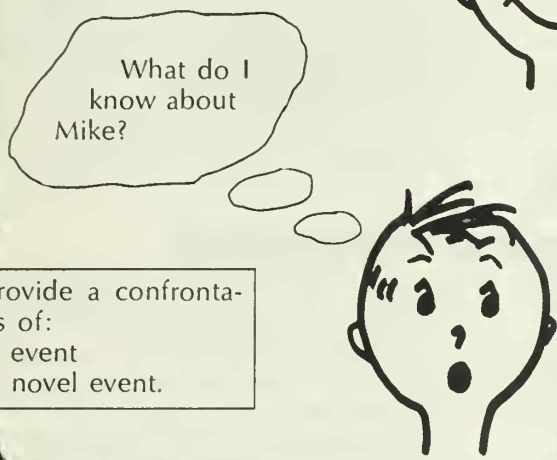
Recognition of an object or event that is new and/or contradicts present understandings.

DISCREPANT EVENT:

A physical event that produces surprise and puzzlement and one that the pupil cannot readily explain.

1

Gain an awareness of the pupil's present concepts, skills and attitudes.



2

Attempt to provide a confrontation by means of:
(a) discrepant event
(b) strange or novel event.

3

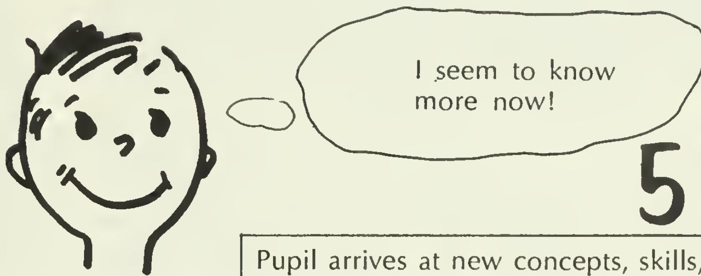
Out of this confrontation attempt to have the student develop a "guess" or theory that might be a possible solution.

4

Have the pupil use the processes of science to investigate and to check his theory by:
(a) experimenting with real things
(b) taking field trips
(c) using audio-visual materials
(d) reading books.

5

Pupil arrives at new concepts, skills, and attitudes.



PROVISIONS FOR THE INDIVIDUAL CHILD

The laboratory approach to science teaching offers special opportunities for achieving individualized learnings. The teacher must so structure the situation that the class is involved in an educationally meaningful situation, while the teacher works with the individual. When all children have available the equipment and materials which are essential parts of the laboratory science program, they will be involved in following suggested investigations, exploring interesting investigations, or discussing their findings with each other. Once this takes place, considerable progress has been made toward individualization of instruction.

In some instances, opportunity should be provided for every child to do the activities individually. However, in most instances, pupils should work together in groups of two or three. The list of recommended equipment (available from Curriculum Branch upon request) is such that ten groups of pupils will be able to work at one time. There will be some instances where the class as a whole may work as a group. This will be particularly true where the teacher is carrying on a demonstration.

Pupils may be grouped randomly or by ability. The teacher, knowing the students in her class, can best determine which method is better to use. Some of the abilities you may wish to consider in grouping students are ability to lead, mechanical ability, and ability to record and interpret data.

When activities of an open-ended nature are provided where the objective is not to come up with one "right" answer, various degrees of thinking and levels of sophistication will develop depending upon the relative abilities of the pupils in the class. The teacher should not expect a uniform level of achievement in her classroom. Children will develop concepts at various levels. By studying the various concepts under each conceptual scheme, the teacher is able to see where the pupil's achievement places him on the "conceptual ladder".

Pupils who are free to inquire, explore and investigate often desire to go beyond the textbook to find answers to new problems that puzzle them, as well as to learn more in depth about the subject they are studying. The teacher serving as a resource person, can guide the pupils to explore varied means of acquiring knowledge. A teacher committed to inquiry teaching will not limit himself to one textbook but will use a variety of materials, both reading and concrete, real materials.

USE OF SCIENCE TEXTBOOKS

While three new series of textbooks have been approved for use in Alberta elementary schools, it is strongly suggested that no one science series should be used to the exclusion of the others or other library books. The texts should be used as references and should in no way constitute the science program.

It is strongly recommended that not more than ten copies of any one series of textbooks be purchased for use in a classroom. This would enable each group of three pupils to have one reference that it might wish to follow or consult when doing an investigation.

Normally direct experiences should come prior to having pupils read from textbooks or references. The science program must not be a read-about science. The science program cannot be taught effectively by using science textbooks alone. Other instructional materials must be used.

SCIENCE EQUIPMENT AND MATERIALS

Each elementary school should contain adequate equipment and materials in order that science may be experienced by the pupil as more than a mere "read and discuss" type of program. For too long a time, elementary school teachers have been expected to scavenge for necessary science materials. It is true that many items can be obtained from home; however, substitutes for some items are both hard to find and very time consuming for the busy teacher. A trend in elementary school science toward a greater emphasis on physical science brings new demands. Under the nature study program, **science was taught descriptively.** Few manufactured materials and equipment were required.

Educators are now concerned that the elementary science program must be considered as more than a body of content to be transmitted to the pupils. The program should foster a critical approach to the subject with an emphasis on experimentation and inquiry rather than the mere assimilation of facts. The teaching of science descriptively must be replaced by a kind of teaching that demands a more questioning, inquiring attitude on the part of both students and teachers. Students who are led to discover for themselves are the ones who really catch the spirit of science and who really understand and develop the basic concepts, the "big ideas", and the process skills.

Good inquiry must be learned and practiced. This involves taking in and processing raw data in the mind and data provides the raw material from which pupils abstract concepts. Because elementary school pupils are going through a developmental stage (Piaget and Inhelder) when their thinking is tied mainly to real things, the laboratory approach to the teaching of science is most essential. Some of the very basic and fundamental ideas of science, therefore, can be developed early in the elementary school by using a concrete approach. The environment for this pupil investigation and inquiry requires equipment and materials appropriate for children's use.

LENSES AND MICROSCOPES

The purpose for using a lens or microscope is to extend the students' powers of observations. The degree of magnification required depends upon the objects with which the student is working. Generally, students in elementary school will not require magnification beyond 100 power. Problems often occur when pupils try to locate objects under a microscope with magnification powers greater than 100. A microscope with 40x magnification will be suitable for most work.

Magnification Devices

NOTE: All prices are subject to change.

1. A piece of small gauge wire with a loop formed at one end dipped in water, can provide students with the basic idea of a lens when they are beginning their study of magnification.
2. Magnifying Lens—Magnification often ranges from 2x to 10x. Two lenses may be used to give magnification up to 20x.
3. Fresnel Lens Teaching Kit for Overhead Projectors—Projected images of such things as salt crystals and brine shrimp, daphnia, etc., can be magnified many times. The lens is available from:

   Educational Products
   c/o Minnesota Mining and Manufacturing Company
   London, Ontario
   Education Price—$6.25

4. Simple microscope—Contains a single glass bead lens. Various powers of magnification; e.g.

   (a) A. S. & E. Microscope — available from McGraw-Hill. An economical little microscope (approx. $3.50) with 90x and 180x (with attachment). Suitable for viewing small objects only.

   (b) Mini-Scope—available from Arbor Scientific Ltd., Box 113, Port Credit, Ontario. An economical microscope that sells for $2.00. Suitable for small things only. Cannot be used with large objects such as pupa, larvae, beetles, etc.

5. Compound Microscope — contains at least two lenses. Several good ones are on the market which are priced between $15.00 - $30.00.

Microscopes used by elementary school pupils should have general utility, be durable and easy for pupils to operate.

The A. S. and E. compound microscope, available October, 1968 (Approx. cost $4.50) has the following advantages over the A. S. and E. single microscope described above: it offers increased working distance and focal length; facilitates observation of wet slides and larger specimens (which simple A. S. and E. doesn't). Magnification—30x and 100x.

Name of Microscope	Strengths and Weaknesses	Approximate Cost	*Distributors
a) B & L Model ESM	Quite good quality resolution. Easy to operate. Recommended for use in Ontario.	40x - $17.00 100x - $19.00	C, W, S, R, M
b) Blister Elementary Microscope	Built-in source, wide field, Blister slides are very good for live specimens. Resolution — good.	50x - $29.00	AVS
c) Swift Elementary Microscope	Zoom power or 10x eyepiece, very good resolution.	40x - 80x $37.00	W
d) Bushnell T60902-2	Very good resolution.	40x, 60x, 100x 150x - $32.00	C
T60902-3	Very good resolution. Good for use in Elementary and Grade 7 Life Science.	100x, 150x - $28.00	C
e) Tasco #904	Long range focusing up to 20mm. thick.	100x - $20.00	T
#906	Very good resolution.	50x, 100x, 300x - $29.95	T
f) Canlab Microscope S6030	Very good resolution. Very good for use in Elementary or Grade 7 Life Science.	50x, 75x, 100x, 150x, 400x, 600x - $28.00	CL

*Key to Distributors:
C—Cenco
W—Welsch
S—Sisco
T—Tasco
R—Raytheon
A—Arbour Sc.
M—McCalaster
A. V. S.—Associated Visual Services
CL—Canlab

Quantity discounts range up to 25%. Considerable savings could be made by purchasing microscopes on a division, county, or district basis.

Activities With Lenses and Microscopes

Beginning in Grade 1, many activities that give pupils opportunities to extend observation skills should be provided in a good science program. Activities might involve observing such things as onion cells, sand, salt, pepper, cloth fibres, hair, micro-organisms, various insects and their body parts, molds, mealworms, feathers, and fingerprints.

REFERENCES

1. *Ward's Natural Science Curriculum Aids* and *Ward's Natural Science Culture Leaflets*

   Available free of charge from:
   Arbor Scientific Ltd.
   Box 113,
   Port Credit, Ontario

   These aids are excellent for all aspects of Life Science.

2. Johnson, Gaylord and Maurice Blaifield, *Hunting With The Microscope,* Sentinel Book Publishers, Inc., New York, New York.

   Available from:
   Cole's Book Store
   Bonnie Doon Shopping Centre
   82 Avenue and 83 Street
   Edmonton, Alberta

3. *Turtox News* and *Turtox Service Leaflets* (free)
   General Biological Supply House
   8200 South Hoyne Avenue
   Chicago, Illinois 60620

4. Gray, *The Use Of The Microscope*
   McGraw-Hill Company of Canada Limited
   330 Progress Avenue
   Scarborough, Ontario

THE USE OF LIVING THINGS

A science room equipped with plants and animals can become a laboratory for stimulating many investigations. When inquiry, observation, and experiments are encouraged, the giving of "ready-made" textbook answers is kept to a minimum. Young children learn to connect cause and effect and find out why certain things happen. Plants and animals stimulate speculation among pupils and lead them to the use of the process skills in conducting investigations.

It is strongly recommended that for teachers who wish to have plants and animals in the school, that the following leaflet be purchased:

How to Care For Living Things in The Classroom[1]

Available from:

The National Science Teachers' Association
Washington, D.C. 20036

Price:

35¢ (U.S. funds)
(Price subject to change)

USE OF AUDIO-VISUAL AIDS

Audio-visual resources may be used to extend direct experience of children. It is never intended that these resources should take, however, the place of actual manipulation of materials. Teachers should use films, filmstrips and other similar materials depending upon the instructional function to be performed. For example, animated films may result in a visualization of molecular activity in solids, liquids and gases that may be superior to mechanical models; or an 8mm. loop may be used to present a problem or stimulate experiments. In another context, materials such as filmstrips, 8mm. loops and transparencies can be regarded as extensions of library resources to which children will have access.

The following points should be carefully considered when using audio-visual materials.

1. Know the purpose to be served by the materials. What learning outcomes do you expect from the experience?
2. Preview the materials.
3. Have a definite reason for using a particular resource or a particular technique at a particular time.
4. Introduce the material to the class or group in such a way that the purpose of the experience is clear.
5. Integrate the experience with the understandings being developed by careful follow-up.

An individual child or group can learn a great deal by investigating audio-visual media independently.

Non-projected materials such as charts, models and study prints or pictures can be used or more sophisticated media such as the following may prove useful.

16 mm. Films

By their very nature films tend to be very highly structured. However, film makers have more recently been attempting to produce films which are much more open-ended. If the sound that something makes is important, the narrator stops talking and lets it be heard. By utilizing the strengths of the film medium, several new films challenge children to think for themselves. Formerly, it was thought that a film should be shown from beginning to end. The teacher should not be afraid to stop a film in the middle if its pace is too fast. In any case, one segment may be all that is relevant. By using headphones connected to a distribution box which is plugged into the projector, a small group can watch and hear a film without disturbing the rest of the class.

8mm. Film Loops

8mm. film, placed in a cartridge so that it will run continuously, has great potential for science teaching. Concepts demanding motion, such as chain reaction, metamorphosis and atmospheric re-entry, in their illustration can now be dealt with effectively. Film taken with a "home-movie" type camera can be loaded into a cartridge for a few dollars. In this way, school experiments can be recorded and filed for future use.

35mm. Filmstrips and 2 x 2 Slides

Filmstrips are excellent sources of pictorial information. The filmstrips format necessitates a fixed sequence of frames There is no reason why any teacher should feel obligated to use all frames or to present them in the original order. 2 x 2 slides may easily be rearranged to provide the best sequence for the purpose. Pictures taken by teachers and students may be readily prepared in this form. Children could use their own slides to record and present some significant activity.

A carefully chosen slide can often provide children with much information and elicit many questions.

Overhead Projector

The overhead projector can readily be adapted to a variety of teaching techniques and individual class situations. Transparencies to illustrate important science concepts may be prepared by the teacher or produced from commercially prepared "masters".

The outlines of opaque objects can be shown. This fact makes it possible, for example, to place a magnet on the projector's stage, sprinkle iron filings on an acetate sheet and let the students observe what happens. An extra fresnel lens can be used to project and magnify a variety of objects, such as live pond specimens in vials, salt crystals, etc. Slides may also be projected in this way.

School Broadcasts

Each school year a number of radio and television programs are presented which can be of help in developing the science program. In September every teacher receives a schedule of these programs, which also gives times and stations.

Audio Tape and Records

If a radio broadcast comes at a poor time for class use, it can be recorded and re-played when needed. Programs from other years are available for copying on the school's blank tape by the Audio Visual Services Branch, Department of Education. Actual recordings of sounds can be made by the teacher or pupils for class use.

Closed Circuit Television Equipment

If the school is equipped for T.V. a number of exciting possibilities are open to the enterprising science teacher. Television programs can be recorded and used in class at the appropriate time. Difficult and dangerous experiments can be demonstrated for the television camera and shown to students at a later time. The television camera will magnify objects so that the whole class can see without crowding around the teacher's desk. Demonstrations with rare or costly materials can be performed once and the video-tape re-shown many times.

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[1]Adapted from: *How to Care For Living Things in The Classroom.* National Science Teachers' Association, 1965.

Addresses of Audio-Visual Suppliers

The teaching suggestions for each conceptual scheme list a number of films and filmstrips for classroom showing that are available from the following suppliers or distributors.

Producer	Distributor
Academy	Academy Films 748 N. Seward St. Hollywood 38, California
Cenco	c/o Eye Gate House Inc. 447 Tinniswood Street Winnipeg 14, Manitoba
Coronet	Sovereign Film Distributors Ltd. 277 Victoria Street Toronto, Ontario
Curr. (Curriculum Films)	Mr. D. C. Lofquist Instructional Materials Center Suite 1510 - 10145 - 121 Street Edmonton, Alberta
E. B. F.	Encyclopaedia Britannica Films Ltd. c/o Mr. Roy Sherwin 9719 - 84 Avenue Edmonton, Alberta
E. F. D.	Educational Films Division John Colburn Associates 1122 Central Avenue Wilmette, Illinois 60091
F. A. (Filmstrip House)	Carman Educational Association Box 64 Pine Grove, Ontario
F. O. M.	Filmstrips of Canada 3333 Metropolitan Boulevard, East Suite 301 Montreal 38, P. Q.
Gateway	Carman Educational Association Box 64 Pine Grove, Ontario
J. H. (Jam Handy)	Jam Handy Company c/o Mr. Gordon E. Watt 15 Ferbane Place Willowdale, Ontario
McGraw-Hill	McGraw-Hill Co. of Canada Ltd. (Text Film Department) 330 Progress Avenue Scarborough, Ontario
N.F.B.	National Film Board Box 6100 Montreal 3, Quebec
S. V. E. (Society of Visual Ed.)	Educational Film Distributors Ltd. 191 Eglinton Avenue East Toronto 12, Ontario
Walt Disney	Encyclopaedia Britannica Films Ltd. c/o Mr. Roy Sherwin 9719 - 84 Avenue Edmonton, Alberta
Y. A. F. (Young America Films)	McGraw-Hill Co. of Canada Ltd. (Text Film Department) 330 Progress Avenue Scarborough, Ontario
Y. L. P. (Your Lesson Plan)	Mr. D. C. Lofquist Instructional Materials Center Suite 1510 - 10145 - 121 Street Edmonton, Alberta

Symbols Used For Audio-Visual Materials

Films	⋈	Records	⊙
Filmstrips	⊟	Slides	[ ]
Tapes	●_●		

SCIENCE FACILITIES

A Science Room

Ideally, a science room of 1,200 square feet should be provided and equipped with plenty of flat surfaces on which to work, electrical and water outlets, means of easily darkening, adequate sources of references, ample display and storage space. Flexibility is an essential quality of a room for science. Rearrangement of the room must be possible with a minimum of effort and confusion. Children themselves should be able to easily find whatever they need for their investigations. This helps them to become more self-reliant and reduces the routine demands on the teacher.

Some Possible Ways of Organizing Your School for Science

1. Science rooms to which pupils move for their science classes.
2. Self-contained classroom making use of mobile carts with tote-boxes. (Plans for mobile carts will be supplied by the Curriculum Branch upon request). This might be desirable for Grades I and II.
3. Self-contained classrooms with adequate equipment for each room. (This is very costly.)
4. A combination of two or more of the above.

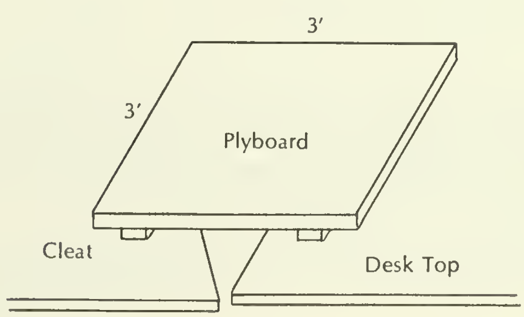
Materials and Equipment Should be:

1. Easily accessible to both teachers and students.
2. Kept together by using tote-boxes or some other similar device or by having it all in a science room.

Large Flat Top Surfaces Upon Which Pupils May Work is Essential

These may be provided by:

1. Moving flat top desks together.
2. Using sheets of 3′ x 3′ plywood with two cleats on one side and placed on sloping desk tops.



3. Using tables, either rectangular or trapezoidal.

PLANNING A FIELD STUDIES PROGRAM

A major goal of science teaching is to devise instructional activities and procedures that will improve the effectiveness of science teaching. In this Guide, inquiry, discovery, and investigation receive major emphasis at all grade levels. In accord with this new emphasis from telling to inquiry, from "show and tell" to investigating, from discrete facts to understanding concepts, field studies assume new meaning and importance.

How to Plan a Field Study:

Choose a field study when it is the best investigational method available for the desired type of learning outcome. In science classes, this usually means when first-hand experiences beyond the confines of the school building cannot be provided as effectively in any other way.

A field study is justifiable when it is a planned learning experience conducted with clearly defined purposes, preferably closely related to class activities. A class is ready for a field study only after appropriate problems are defined and the probable sources of data enumerated. Without such preplanning a field study trip will result in random observations.

a) Preparing a Field Study Outline — A study outline is frequently used as a means for increasing the effectiveness of a field study. The study outline should contain: a short description of the problem, the questions to be resolved, and the observation to be made. It should identify what is to be accomplished and enumerate what responsibility the student has for each activity. It may suggest data to be assembled, processes to be observed, or specimens to be collected.

   It may also include data charts for the convenience of recording observations. Maps of routes showing points for observation and diagrams of resource sites may be useful. A list of essential equipment, supplies and special instructions form a part of this outline.

b) Choosing a Resource Site — Selection of the resource site should be made in terms of specific criteria which might include such things as the following: the possibility of seeing a scientist at work, the convenience of the site to the school, the chance to correlate science with other school subjects, and opportunities for students to make use of knowledge for interpreting a wide range of conditions and phenomena.

c) Assigning Responsibilities to a Conductor — The teacher should determine in advance whether he must assume the responsibilities for preparing and serving as a conductor or if such a person will be provided at the resource site. The teacher should provide the conductor with an outline of what the class wishes to know, the questions that may be asked, and some idea of the science background and maturity level of the students.

d) Making Arrangements for the Use of the Site — Certain mechanical details such as the following must be attended to: Should all students visit the site? How much supervision will be required? When is the best time of the day or year to visit the site? How much time will the visit require? What points on the way to the site are of special interest? How should the class be organized?

e) Checking Details — Arrange permission and transportation well in advance of the trip. Send home parent permission forms and check returns. Send a copy of the study outline to any adults who are to assist with the trip. (Don't forget your school board.) Confirm with those in charge of the site, three days before you visit, that you will be arriving on schedule.

   Student committees might well determine such things as: suitable dress, accessible equipment, behavior standards, safety rules, marking-out the itinerary on a map showing special points to be observed.

f) Following-up — Some specific purposes of the field follow-up might be:

   i) to obtain reports from the various committees on the data gathered so that information may be shared, interpreted, clarified or appraised.

   ii) to organize and review the ideas and materials gained by oral or written reports, bulletin board displays, demonstrations, worksheets, discussions, use of photographs, tests or identification of specimen materials obtained on the trip. Each student should have some responsibility in interpreting what he saw and explaining what it means.

g) Evaluating — The teacher will attempt to determine the degree to which her purposes for taking the field study were met. Evidence might include having pupils complete a "Field Study Evaluation Form", student prepared booklets, and evidence that might be collected to support the general objectives of elementary school science.
(See — Pupil Evaluation).

GRADE I

CONCEPTUAL SCHEME A

When energy changes from one form to another, the total amount of energy remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

electric clock, record player, damaged record, gasoline-powered model airplane, balloons, string, plastic boat, pan, aluminum foil, small wagon, toys, doll carriage, elastic bands, dinky cars, steel balls, cardboard box, block of wood, sandpaper, magazines, fork, rotary egg beater, construction set of matchbox series or similar, single pulley, twine, blocks, balls, chair, wide-mouthed jars, food coloring, washers, magnets, thumb tacks, seeds, pennies, tin cans.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⧓	Films	⊙	Records
⧓8	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Energy must be used to set an object in motion or to alter its motion.**	Media: ⊟ *Introduction to Energy*, Y.L.P.
a. Electric energy may be used to set an object in motion.	
Skills: Observing, Communicating, Predicting.	1. Show an electric clock to the children. How can we make it run? Plug in the cord. Do you see anything? Reference: C.I.S. T4
Observing, Inferring.	2. Get a damaged record. Place it on the turntable. Disconnect the cord. Why has the record stopped moving? Media: ⧓ *Energy and Matter*, E.B.F. ⧓ *Making Things Move*, E.B.F.
b. Chemical energy may be used to set an object in motion.	
Skills: Observing, Inferring.	1. Arrange a demonstration using an almost empty gasoline operated mower. Why won't it go now? Add some gasoline. What made it go again? References: C.I.S. T5 S.T.W. T26-27
Classifying.	2. Children gather pictures of machines that get energy from gasoline along with pictures of other machines that get their energy from electricity, man, etc. Have them classify.
c. The energy in moving air may be used to set an object in motion.	
Skills: Observing, Inferring.	1. Place a balloon on the table. How can you make the balloon move without touching it? Offer the children a cardboard fan. Have the children trace the energy changes. (e.g., energy of pupil blows air—energy of moving air hits balloon—balloon moves.)
Observing, Experimenting.	2. Tie a string an inch from the edge of a piece of paper. Have the children walk with it. Why does it go up in the air? Have the children trace the energy changes (energy of pupil required to pull paper). Reference: S.T.W. T20-25
d. The energy in moving water may be used to set an object in motion.	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Observing, Predicting, Experimenting.	1. Place a plastic toy in a pan of water. Can you think of two ways of making the toy move without touching it? Reference: C.I.S. T7
Observing, Inferring.	2. Make a pinwheel of aluminum foil. Hold the pinwheel in a gentle stream of water. What makes it move? Have the children trace the energy changes (energy of moving water to turning pinwheel).
2. **Energy is used to do work.**	
a. A machine is used to help push or pull an object.	
Skills: Observing, Interpreting data, Defining terms, Inferring, Quantifying.	1. Initiate a discussion by asking children to recall some objects with which they have been playing or working. Direct their attention to methods used to move objects above the floor and emphasize the terms **push** and **pull**. Help them to understand that such activities as kicking a ball or swinging a bat are ways of pushing an object. Emphasize source and point of application of the push or pull. Develop the idea that something must move in order for work to be done. Media: *The Story of Machines,* C.F. Reference: *Laidlaw,* T-P 105-117
Inferring, Quantifying.	2. Place articles into a toy truck. Another child pulls the truck. What part of the truck makes the work easier? References: C.I.S. T8, 9 S.T.W. T44-49 Media: *Making Things Move,* E.B.F.
Classifying, Communicating.	3. Have children gather and classify pictures or collections of toys according to whether each machine helps to **push** or **pull.**
b. Energy is used to overcome friction.	
Skills: Quantifying, Interpreting data, Defining terms, (friction).	1. Attach an elastic band to a toy truck. Which is the easier way to move the truck, on its side or on its wheels? Record length of elastic band in each case (e.g., number of sticks long). References: C.I.S. T10, 11 S.M.A. T48, 53
Quantifying, Interpreting data.	2. Place a flat piece of board on top of some steel balls that have been placed about 6" apart on the floor. If a boy sits on the board, can he be moved easily?
c. More energy is used to overcome sliding friction than to overcome rolling friction.	
Skills: Observing, Inferring.	1. Children bring a box and a wagon. Have them take turns at pulling each other, first using the rope tied to the box, then the wagon. Reference: C.I.S. T12, 13
Quantifying, Communicating, Interpreting data.	2. Attach a block of wood for pulling. Pull it along a smooth floor and then over some sandpaper. Place steel balls under the block of wood to serve as rollers. Pull across the sandpaper again. Measure with spring balance and record. Why is it easier to move now?
3. **Energy must be used to do work.**	
a. The greater the amount of work done, the greater the amount of energy expended.	
Skills: Observing, Predicting.	1. One child touches his toes rapidly while another does the same thing slowly. Record the scores for 10 seconds play for each person. Was the time the same for all? Does it take more energy for a child to move rapidly than to move slowly? Reference: C.I.S. T13
Observing, Classifying.	2. Children seek illustrations of things that use much energy to go fast but not so much energy when going slowly, i.e., horse galloping or walking, boy running or walking, etc.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
b. More work can be done in less time when machines are used.	
Skills: Observing, Inferring, Communicating.	1. On separate slips of paper ask several children to write a message for 20 others. Note the time this takes. Have one child print this same message on a stencil. Take the class to the duplicating machine. Discuss the time taken to produce copies. Reference: C.I.S. T16
Observing, Predicting.	2. One child tries to whip cream with a fork, another with a rotary eggbeater.
c. The rate at which energy is supplied determines the rate at which work is done.	
Skills: Inferring.	1. Select a child to carry two books across the room. Repeat with other children each carrying the same number of books. Why do two children do more work than one? Reference: C.I.S. T14, 15
Observing, Communicating, Experimenting.	2. Children bring a construction set of dinky toys. Have them demonstrate how the machines operate and tell about the work they do.
d. The rate at which energy is used determines how fast the work can be done.	
Skills: Observing, Communicating.	1. Fasten a pulley. Tie a weight to one end of a rope and thread the other end through the pulley. If you pull quickly on the loose end of the rope, does the weight move faster or slower? Reference: C.I.S. T17
Inferring, Predicting, Quantifying.	2. Repeat the experience of using a pulley to lift a weight. Remove the rope from the pulley and let the children take turns raising a basket by pulling the twine over the back of a chair. Which is the easier way to lift the weight? Children could use a spring balance and record their observation and compare. Reference: C.I.S. T58-60
4. **Energy must be used to do work.**	Media: *Gravity*, McGraw-Hill *Gravity*, Y.A.F.
a. Energy must be used to do work against the pull of gravity.	
Skills: Observing, Inferring.	1. Children take turns tossing a ball in the air. What does the ball do after it is tossed? What makes it go up? What makes it come back down? Reference: C.I.S. T20-22
Observing, Predicting.	2. Have a child pour colored water from one tumbler to another. Why does the water go down into the tumbler rather than up to the ceiling? Can you think of two ways to get this water from the tumbler to your mouth?
b. A force can be used to counteract another force.	
Skills: Observing, Predicting.	1. Children fasten one end of rubber band to surface. Stretch band with other hand. How many forces are acting on the band? Measure force with scale. Now take the band and stretch from both ends and measure with two scales. Do the scales read the same? Is work being done?
Observing, Predicting.	2. Blow up an oblong balloon. Hold it neck down. What will happen when I let it go? When the children observe that the balloon goes off, up and sideways before it falls, repeat the investigation with other balloons. What makes the balloon take off? What pulls it down? 3. Have some children individually sit on a board that has been placed on top of some steel balls and then throw a ball. Have them predict what they think will happen. What happened?
5. **Force is used to counteract force.**	Media: *Magnets*, McGraw-Hill *Magnets and How We Use Them*, Jam Handy *Magnets Can Attract Through Objects*, Jam Handy Reference: *Exploring Science*, Thurber T54-58

a Magnetic forces can be used to overcome the force of gravity.

Skills: Observing, Predicting.

1. Give children a magnet and three metal washers. Ask the children if they can think of ways in which the washers might be picked up quickly. Children use the magnet to pick up the washers.

Reference: S.T.W. T50, 51

Observing, Inferring, Experimenting, Classifying.

2. Give children a collection of 3 to 4 nails, one of which is aluminum. Have the children use their magnets to pick up the nails. (A discrepant event occurs when aluminum nail cannot be picked up.) Supply the children with other objects e.g., lead weights, bobby pins, plastic vials, etc. Have the children classify objects. Will a magnet attract another magnet? Have the pupils find out. Do the magnets push or pull?

b. Magnets do not have to touch objects to exert force on them.

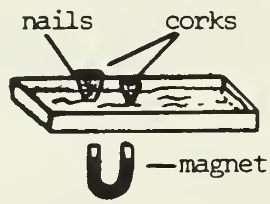
Skills: Observation.

1. Put a small washer inside a tumbler. Move a magnet beneath the glass. Does the washer move? Does a magnet work through glass? (Emphasize pull).

Reference: S.T.W. T52-53

Observation, Interpreting data.

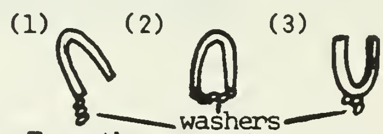
2. Unobserved by the pupils, place some nails inside one cork. Place the cork with the nails in it and another cork in a pan of water. Without the children seeing, move the magnet around under the corks. Have the children tell you why they think one cork moved and the other didn't.



c. The greater the force, the greater is the amount of work done.

Skills: Observing, Inferring, Communicating, Quantifying.

1. By using a "U" magnet see how many washers (children may tally) can be picked up when it is used as follows:



Try other magnets.

References: C.I.S. T27 S.T.W. T56

GRADE I

CONCEPTUAL SCHEME B

When matter undergoes a chemical change, the total amount of matter remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

rocks, plastic bags, bowl, food coloring, ice cubes, sand, fork, sugar cubes, thermometer, modelling clay or "silly putty". plastic dish, butter, shortening, wax, magnifying glasses, sponge or cloth, two pint jars, 26" x 8" pieces of cloth, cologne or alcohol, bottle of ginger ale, kettle, cookie sheet, glass, spoons.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)

S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)

S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⋈ Films
⋈8 Film Loops
Filmstrips
⊙ Records
●_● Tapes
[ ] Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Matter exists in various forms and states.**	
a. Matter may exist as solid, liquid or gas.	
Skills: Observing.	1. Place some rocks and some water in plastic bags. Sweep an open plastic bag through the air and then tie. Let the children feel as well as look at the bags. Discuss shape. Do several investigations to establish properties of air. Reference: C.I.S. T30 Media: *Solids, Liquids, Gases and Molecules,* Y.L.P.
Observing, Inferring.	2. Children empty bags of rocks. What happens to their shape? What happens when the water is emptied into the bowl? How can you tell that the air has gone out of the third bag?
b. Common forms may exist as either a solid, liquid or gas.	
Skills: Observing, Inferring.	1. Place rocks in one plastic bag, pour colored water in another and fill a third bag with air. Children empty the three bags into a large jar with water in it. Do the rocks keep their shape when they are in the water? Does the water keep its shape? Is the air going out of the bag? How could you find out? References: C.I.S. T31 S.T.W. T7
Classifying.	2. Children collect objects and pictures which are solids, liquids and gases. Use a modelling clay or "silly putty" to show that some substances are difficult to classify. Sand might be used here. How is sand different from a liquid? You can feel the particles of sand which is not possible with the liquid. Reference: S.M.A. T40-44
c. The state of matter can change.	
Skills: Observing, Predicting, Communicating.	1. Stack 3 to 4 sugar cubes on a plastic dish. Ask the children to predict what would happen if a small amount of water were poured around the cubes. Discuss the changes that occur. Take a drop of sugar water solution. Let water evaporate. Taste the solution. Have children observe crystals with magnifying glasses. Emphasize change. References: C.I.S. T32 S.M.A. T32, 34 T37-38
Observing, Communicating.	2. Children collect and prepare a display of items that change from a solid to a liquid, i.e. butter, shortening, wax. These substances will melt in warm sunshine.
d. Heat energy can be used to change a solid to a liquid.	
Skills: Observing, Predicting, Inferring, Quantifying.	1. Present two identical containers each with a few pieces of ice. How can the ice be made to melt faster? Place one pan in direct sunlight on the windowsill and one in the shade. Keep a record of the time required for ice to melt in each pan.
Observing, Communicating, Predicting, Inferring.	2. Children explore with thermometers in ice water, cold, and warm water. What do you see? Reference: C.I.S. T-33
e. Heat energy is given off when a liquid changes to a solid.	
Skills: Observing, Inferring.	1. Record the temperature of warm water. Place the warm water outdoors or in a refrigerator. Record the temperature when the water has turned to ice. Help the children to see that getting cold means losing heat. Reference: C.I.S. T34
f. Matter changes in state as the temperature changes.	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Observing, Communicating, Inferring.	1. Record the temperature of snow. Observe crystalline shape of snowflakes with a magnifying glass. Make a little snowman. Put it in a pan and bring it indoors. Leave it to the end of the day. Record the temperature. Discuss. References: C.I.S. T35 S.T.W. T18, 19
Observing, Predicting, Communicating.	2. Keep a daily record of outdoor temperatures. Take readings in the same place and at the same time each day.
g. When liquids evaporate gases are formed.	
Skills: Observing, Inferring, Predicting, Communicating.	1. A child makes a strip on the chalkboard with a wet sponge. What happens to the water? Make two other wet spots on the board. Have a child fan one spot to make it dry faster. References: C.I.S. T36 S.T.W. T8-11
Observing, Inferring, Quantifying.	2. Children place water in a jar and mark level. With a glass-marking pencil record the water level each day. What do you see happening? Can you tell why?
h. Heat energy is needed for evaporation to occur.	
Skills: Observing, Quantifying.	1. Put equal amounts of water into two jars of equal size. Mark the water level of each with masking tape. Store one jar in a cool place, the other in a warm place. From which jar does the water evaporate faster? References: C.I.S. T37 S.T.W. T8
Observing, Predicting.	2. Soak two 6″ x 8″ pieces of cloth in water. Place one in the coolest place in the room and the other on a register. Which piece of cloth will dry first?
2. **Matter exists in various forms and states.**	
Skills: Observing, Inferring.	1. Put a dab of cologne or alcohol on the back of each child's hand. Let the children observe (see, feel, smell) what happens as the liquid evaporates. Reference: C.I.S. T38
Observing, Inferring, Predicting.	2. Bring in a bottle of ginger ale. Open it and ask the children to show you three different states.
3. **Evaporation and condensation are changes in the state of matter.**	Media: ⧓ *Finding Out About Clouds*, S.V.E.
a. When warm air touches a cold object, water comes out of the air.	
Skills: Observing, Inferring.	1. Boil a kettle. Place a cookie sheet in the vapor. What do you see on it? Is the water in tiny droplets or in large drops? Where are the drops of water coming from? References: C.I.S. T41 S.T.W. T12-15
Observing, Inferring.	2. Fill a tumbler with ice cubes (cold water). Place it in a warm room. What do you see on the outside of the tumbler? Where did this water on the outside come from?
b. Clouds and precipitation result from the cycle of evaporation and condensation.	
Skills: Observing, Predicting, Inferring.	1. Boil a kettle of water. Place a cold pan in the cloud of water vapor. Leave the drops of water for a few hours. Where did the water go? References: C.I.S. T41 S.T.W. T16-17 *Search and Discover*, T133-136
Observing, Predicting, Inferring.	2. Use a wide-mouthed bottle. Cover the bottom with some soil. Moisten the soil with about ½ cup of water. Cover the top with a plastic bag. Set the bottle on a window sill and observe. What did you see form on the plastic top and on the sides of the jar. Where did this water come from? What happens to these drops of water?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
c. The cycle of evaporation and condensation is a result of heat exchange.	
Skills: Observing, Inferring.	1. Chill some spoons. Children exhale gently on the spoons. What do you see on the spoons? What is the cloud made of? References: C.I.S. T-44 S.T.W. T16-17
Quantifying, Inferring, Controlling variables.	2. Children measure one cup of water into two identical glasses. Mark the water level with adhesive tape. Ask them to find a dark place in the room for one jar and a place where it will get heat from the sun for the other.
d. The weather cycle is related to the water cycle.	
Skills: Observing, Predicting, Inferring.	1. Use the opaque projector to discuss the picture on page 47 of C.I.S. Are the farmhouse and the barn getting wet? Why not? Reference: C.I.S. T46, 47

GRADE I

CONCEPTUAL SCHEME C

Organisms are interdependent with each other and with their environment.

SUGGESTED MATERIALS AND EQUIPMENT

soil, cups, bean seeds, dropper, aluminum pan, cotton seeds, mealworms, plastic, sand, stones, aquarium or fish bowl, aquarium plants, magazines, apple, tomato, board.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⋈ Films
⋈8 Film Loops
⊟ Filmstrips
⊙ Records
●—● Tapes
[ ] Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. There is an interchange of matter and energy between living things and their environment.	Media: ⋈ *What Plants Need for Growth,* E.B.F. ⋈ *Learning About Seeds,* E.B.F.
a. All living things need food, water and air to survive.	Reference: S.T.W. T102-103
Skills: Formulating hypotheses, Quantifying, Predicting, Interpreting data.	1. Children fill two cups with sifted soil. Plant 3 seeds in each cup. Give cup A 15 drops of water daily. Give cup B 1 drop daily. Reference: C.I.S. T96-99
Observing.	2. Make two observation sprouting gardens by using two aluminum pans. Put a thin layer of cotton on the bottom of the pans. Wet the cotton. Cover with clear plastic. Place the boxes in a warm but shady place. When seeds sprout sift some good soil over one box of sprouts. Keep the soil damp and leave the gardens in the shade until the plants come up. Are there any differences in the two gardens?
b. Plants and animals interact through a food relationship.	
Skills: Observing, Inferring.	1. Set up aquarium in classroom. What do you see in the aquarium? References: C.I.S. T106-107 S.T.W. T102-103
Observing, Inferring.	2. Using wide-mouthed bottles and slough water, along with a few plants obtained from the slough, have the pupils establish their own aquarium. What causes the water eventually to turn green? What do the little animals eat? Observe the animals with a lens. Would tap water turn green in time?

2. Organisms reproduce their own kind.

Media:
- *Farm Animals*, S.V.E.
- *The Turtles*, Curr.
- *How Animals Live In Fresh Water*, H. 16
- *How Animals Live in Grasslands*, H. 17
- *Animal Babies*, S.V.E.
- *Finding Out How Animals Live*, S.V.E.

a. The size and structure of an organism is determined by heredity and environment.

Skills: Observing, Inferring, Classifying.

1. Children match picture puzzles of animals and their babies.

Observing, Classifying, Inferring, Predicting.

2. Children bring pets to school. Library research to find out what these animals' parents are like.

References: C.I.S. T82, 83, 110-112
S.T.W. T-Unit VI

b. Anatomical structure in animals relate to function.

Skills: Observing, Inferring, Classifying, Communicating.

1. Have children observe mealworms, spiders, beetles, goldfish and pictures of other animals to see how their structure suits them to their environment, e.g., gills for breathing, shape of mouth for eating, shape of body for moving . . .

Reference: C.I.S. T112, 113

Observing, Inferring, Classifying, Communicating, Formulating models.

2. Children prepare charts showing animals that climb, animals that fly, animals that have fins, animals that have feet which help them to climb. Consider goldfish in aquarium. What function do gills serve, mouth, tail, various fins, eyes, etc.?

3. There is an interchange of matter and energy between living things and their environment.

a. Hereditary factors develop within a given environment but the characteristics of the species are not generally altered.

Media:
- *Paul's Puppy*, Curr.
- *Billy Beaver*, Curr.
- *Terry's Turtle*, Curr.
- *Living Things Are Everywhere*, F.O.M.
- *How Animals Prepare for Winter*, N.F.B.
- *How Animals Live in the Arctic*, Curr.
- *Animals of the Pond*, Curr.
- *Hibernation*, Curr.
- *Reptiles of the Desert*, E.B.
- *Insect Homes*, Jam Handy
- *The Desert*, Curr.
- *The Turtles*, Curr.
- *Birds of Our Community*, S.V.E.

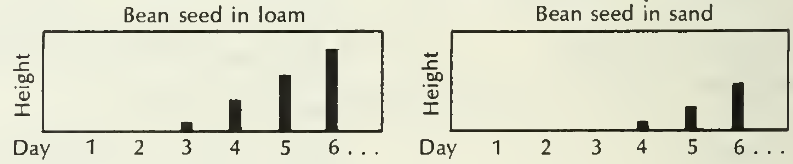
Skills: Observing, Inferring, Quantifying.

1. Present an apple and a tomato to the children for identification. What is found inside each fruit? What could grow from apple seeds?

Observing, Quantifying, Communication.

2. Children plant a bean seed in loam and one in sand both at the same depth. As the first plant breaks through the surface start a graph using strips of paper.

Bean seed in loam | Bean seed in sand



Observing, Inferring, Quantifying.

3. Study mealworms. Compare mealworms for size and shape. Do they all have the same number of legs, segments to body?

b. The size and structure of an organism are limited by heredity regardless of the environment.

Skills: Observing, Inferring.

1. Place a board over some grass for about one week until the grass beneath it has lost its green color. Observe the effect on the grass of the lack of light. Remove the board and observe the grass return to its original green.

References: C.I.S. T115 S.T.W. T65

Media:
- *Finding Out How Animals Live*, S.V.E.
- *Animal Babies*, S.V.E.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
c. Different kinds of animals live in different places.	
Skills: Observing, Communicating.	1. Children preview filmstrips. Report on: What kind of home does the animal require? What does it eat? Where does it get its food? Select a variety of animals from different habitats. Supplementary References: *Laidlaw, Bk. 1,* pps. 8-24 *How Do We Know,* Beauchamp, pps. 55-61 *Science Near You,* Craig, pps. 76-81
Observing, Inferring, Communicating.	2. Teacher and pupils prepare a map showing places where animals live.
	3. A field trip to a pond, a flowing stream and a wooded area to observe and collect specimens should be attempted. (See Field Study Program on page 18 of this guide.)
d. Animals build homes that suit the environment in which they live.	
Skills: Observing, Classifying, Inferring.	1. Take the children on a field trip to study animal homes. (Many homes of insects can be found right in the school yard.) Why do ants build homes like they do? Why do ants not build their homes in ponds like the beaver? Why do bees build their homes in trees or in protected places? Why is a burrow a good home for a gopher? Reference: S.T.W. T114-118
Observing, Classifying, Inferring, Communicating.	2. Children prepare a class booklet of animals and their homes.

GRADE I

CONCEPTUAL SCHEME D

Living Things are products of their heredity and environment.

SUGGESTED MATERIALS AND EQUIPMENT

30 lima beans, magnifying glasses, 2 jars, seeds, pussy willow branch, geranium, non-tuberous begonia, damp sand, toothpicks, mouldy orange, a good orange, hard boiled eggs, frog eggs, chicken eggs, turkey eggs, duck eggs.

SUPPLEMENTARY REFERENCES

Adrian, Mary, *Honeybee Tells Honeybee*. Don Mills, Ontario: Saunders of Toronto Ltd., 1952.

Beauchamp, Wilbur, *All Around Us*. Scarborough, Ontario: Gage, 1953.

Blough, Glenn, O., *Animals and Their Young*. New York: Harper and Row, 1958.

Collier, Ethel, *Who Goes There in My Garden*. Don Mills, Ontario: Saunders of Toronto Ltd., 1963.

Doering, Harold, *An Ant is Born*. Don Mills, Ontario: Saunders of Toronto Ltd., 1946.

Doering, Harold, *A Bee is Born*. Don Mills, Ontario: Saunders of Toronto Ltd., 1962.

Elementary Science Study, *Science Through Discovery*. Singer Science Series, Don Mills, Ontario: J. M. Dent, 1967. (A good teacher and pupil reference for this conceptual scheme.)

Miner, Opal, *True Book of Plants We Know*. Chicago: Children's Press, 1953.

Selsam, Millicent, *All About Eggs*. Don Mills, Ontario: Saunders of Toronto Ltd., 1952.

Sutherland, Lucille, *Our Science Table*. St. Louis: Miliken Publishing Co.

Webber, Irma E., *Up Above and Down Below*. Don Mills, Ontario: Saunders of Toronto Ltd., 1943.

Code for Media:

⧓	Films	⊙	Records
⧓8	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

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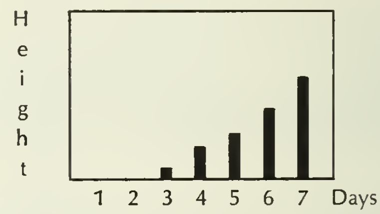
S.M.A. — *Science, A Modern Approach*, Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Living things reproduce their own kind.**	
a. Plants can reproduce their own kind through seed.	1. What is inside the seed? Can you find the new food for the new plant? Use a magnifying glass.
	References: C.I.S. T62-63 S.M.A. T66-95
Skills: Observing, Communicating.	Media: ▶◁$_8$ *Bean Sprouts,* McGraw-Hill, LK-63.
Observing, Communicating, Inferring, Hypothesizing.	2. Use some soaked lima beans and some dry ones. Soak a blotter and then insert it over the soaked beans which have been placed inside the jar. Place the dry beans beside the jar. What happens? To show how fast the bean plant grows, graph the growth of the bean sprouts by using strips of paper. Histogram T94, S.M.A. to show average height. 
b. Seeds produce the kind of plant from which they come.	Reference: S.T.W. T65
	Which way is the rootlet growing? Examine with a magnifying glass.
Skills: Observing, Inferring, Predicting, Hypothesizing.	1. Present some seeds from opened packets. Plant these. Which one will come up first? Identify as they begin to grow. Do they grow at different rates?
	References: C.I.S. T64-65 S.T.W. T65
Observing, Inferring.	2. Children bring a variety of fresh vegetables. Discuss which parts of the plant we use as food.
	Media: *New Plants From Seeds,* Jam Handy *Let's Learn About Seeds,* McGraw-Hill
c. Some plants can reproduce new plants from parts of the old.	1. Trim the cut ends of either a pussy willow branch or a geranium. Keep in water until the roots are well developed. Plant in the school grounds or in the classroom.
	Reference: C.I.S. T66-67
Skills: Observing, Inferring.	Media: *New Plants from Old Plants,* Jam Handy
Observing, Hypothesizing, Interpreting.	2. Make slits at the edge of the leaf of a non-tuberous begonia so as to cut the veins. Place the leaf top surface down on damp sand. Fasten the leaf with toothpicks and cover it with an inverted glass to keep it moist.
	3. Cut a segment, which contains an "eye", from a potato.
d. Some plants reproduce new plants from spores.	1. Present a mouldy piece of orange and a good orange. What is on the orange? Place the good orange in a covered, sealed box. What will happen to the orange in a few days?
Skills: Observing, Communicating, Interpreting.	Reference: C.I.S. T68-69
Observing, Inferring, Investigating.	2. Investigate, using magnifying glasses, how mould plants grow and reproduce.
	Reference: C.I.S. T69
e. Plants are dispersed to new environment by means of seeds.	
Skills: Observing, Predicting.	1. Field Experience: Find places where grass grows, i.e., cracks in the pavement. Did someone plant it there? Pupils might study dandelion seeds.
	Reference: C.I.S. T72-73
Observing, Communicating, Predicting.	2. Field Experience: Students collect dandelion seed heads and then pull out the "parachutes." Examine them through magnifying glass. Why do the seeds float so easily in the air?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
f. The sun is the source of energy for the reproduction and growth of the green plants.	
Skills: Observing, Communicating.	1. Students can report upon the kinds of plants that grow on the side of their house where there is very little sunlight.
Observing, Investigating, Analyzing, Communicating.	2. Investigation: Discovery that green plants need sunlight. Reference: C.I.S. T73
g. Some animals reproduce their own kind through eggs laid externally.	
Skills: Observing, Predicting, Inferring.	1. Students peel and cut apart a hard boiled egg. Call attention to the outer shell, the lining, the white and the yolk. Where else could you find eggs? What else are eggs used for? Reference: C.I.S. T76
Interpreting data, Reporting, Communicating.	2. Use pupil prepared charts and exhibits to show animal babies that come from eggs laid externally. Media: *Birds of Our Community,* S.V.E., (PK-5247)
h. Some animals pass through a cycle of change from egg to adult.	1. Find out about the stages in the life of a moth? What are they? Or watch a mealworm go from larvae (mealworm) to pupa, to beetle (adult) to egg. Reference: C.I.S. T79
Skills: Observing, Interpreting, Interpreting data, Inferring.	Media: *Butterflies,* E.B.F. *The Monarch Butterfly,* E.B.F. 8 *Caterpillar to Moth,* I.C.F.
i. Some animals develop through stages before appearing like the parents.	
Skills: Observing, Predicting.	1. Secure eggs from a pond along with extra water and water plants. What is a tadpole? Reference: C.I.S. T81 Media: *Secret of Life,* McGraw-Hill
Interpreting data, Communicating.	2. Observe the eggs for several days. Library Research and report. What changes do you observe?
j. Mammals bear their young alive; they do not lay eggs. Skills: Observing.	1. Initiate discussion of farm animal babies through a bulletin board display. What are the babies like? How many legs does each one have? Mice, gerbils or hamsters, with their young, may be studied. Reference: C.I.S. T82-83 Media: *Finding Out About Mammals,* S.V.E.
Observing, Classifying, Communicating, Interpreting.	2. Make a class exhibit of animals that bear their young alive. Media: *Animal Babies Grow Up,* Sovereign
k. Mammals bear their young alive. The offspring resemble the parent.	1. Urban students should plan field trips to a farm or a zoo. Report on animal babies and their mothers. Pictures of babies may be matched with their mothers.
Skills: Observing, Classifying, Communicating.	Media: *Farm Babies and Their Mothers,* Dept. of Education, F.A., TK-1225 *Feeding the Animals,* E.B., PK-2848
Observing, Communicating.	2. Rural students can report upon the kinds of animal babies and their mothers that they have on their farms.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
I. Eggs have identifiable characteristics which can be related to the animal that produced them.	1. How do these eggs differ? Secure eggs from a hatchery or a farm (duck, turkey and chicken eggs).
Skills: Observing, Classifying, Predicting.	References: C.I.S. T88-89 S.T.W. T105-114
Observing, Interpreting data, Communicating.	2. Library Research: Notice the different kinds of birds' eggs. Report on them. Are robin eggs always blue?

GRADE I

CONCEPTUAL SCHEME E

Livings things are in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

pictures and models of dinosaurs, sea shells, leaves, bones, sand, dead ant or fly, ice cube tray, popsicle sticks, rubber cement.

SUPPLEMENTARY REFERENCES

Brown, Stanley and Barbara, *The Story of Dinosaurs and the Age of Reptiles*, New York: Harvey House Publishers, 1958.

Farb, Peter, *The Story of Life: Plants and Animals Through the Ages*, New York: Harvey House Publishers, 1962.

May, Julian, *They Lived in the Ice Age*, Don Mills, Ontario: Saunders of Toronto Ltd., 1967.

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Posin, Daniel, *What is a Dinosaur?* New York: Harper and Row

Slobodkin, Louis, *Dinny and Dannv*, Toronto: Macmillan Co. of Canada, 1951.

Whitaker, George and J. Meyers, *Dinosaur Hunt*, New York: Harcourt, Brace and World, Inc., 1965.

Zim, Herbert S., *Dinosaurs*, New York: William Morrow, 1954.

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⋈	Films	⊙	Records
⋈8	Film Loops	●_●	Tapes
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S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Animals of the past were different from the animals of the present.**	
a. Life in the past is reconstructed from fossil remains.	Media: ⊟ *The Story Fossils Tell*, E.B.
Skills: Observing, Communicating.	1. Introduce the concept with a display of dinosaur pictures or models. Who were these strange animals that lived long ago? How did they look? In what kind of surroundings did they live?
	Reference: C.I.S. T128, 129
Observing, Inferring, Interpreting data.	2. Take the children to a museum or any other place where dinosaurs may be viewed. Make plasticine replicas.
Observing, Communicating, Inferring, Predicting.	3. Children discover how fossil prints were made by making some prints of their own. Make hand and foot prints in mud; make prints with sea shells, bones, leaves.
	Media: ⊟ *Animals of Long Ago*, Curr.
	Reference: C.I.S. T132
Predicting, Formulating hypotheses, Inferring.	4. Make a pan of mud. Stir it until it is as smooth as pancake batter. This mud represents sediment deposited on the bottom of the ocean. While the mud is being stirred, let pupils take turns in dropping in shells, fish bones, crab claws, bits of coral, chicken skeletons, etc. Everyone should add something. Set pan aside and allow mud to dry. When mud is hard let pupils break it apart, discovering "fossils" and imprints in mud.
Interpreting, Communicating.	5. Relate the story of the deep freeze mammoth. Listen for the main idea. Children then may ask the teacher any question they like about the incident.
	Reference: C.I.S. T136

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Communicating.	6. What does your mother freeze? Why? Interview mothers and report back to the class.
Observing, Communicating, Predicting.	7. Drop a dead ant or fly into an ice cube tray. Fill with water. Place in either refrigerator or outdoors if the temperature is cold enough. What will this insect look like in a week from today if the ice does not melt? Reference: C.I.S. T137
Skills: Communicating, Observing, Predicting.	8. Tell the children the story of the California tar pools. Children listen for the main idea and then report or ask questions. Reference: C.I.S. T139

GRADE I

CONCEPTUAL SCHEME F

The Universe and its component bodies is constantly changing.

SUGGESTED MATERIALS AND EQUIPMENT

globe; flashlight; black paper; yellow chalk; broom handle; transparent, translucent, and opaque material.

SUPPLEMENTARY REFERENCES

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Code for Media:

▶◀	Films	⊙	Records
▶◀8	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Code for References:

C.I.S. — *Concepts in Science,* Longmans.

S.M.A. — *Science, A Modern Approach,* Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World,* Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. The sun is the source of our light energy.	
a. Day and night result from the rotation of the earth. Skills: Observing, Inferring, Communicating, Predicting.	1. Fasten a marker to a globe that will show the children where they live. With a flashlight direct the beam of light at the place where the marker is. Why is it day here? Turn the globe. Shine the flashlight on it. Through further demonstrations, lead children to understand that as the earth rotates, half of the earth is always in the light and the other half in the dark. How much of any ball can be seen at one time? Reference: C.I.S. T50-53
Observing, Communicating.	2. Have the children observe the night sky. On sheets of black paper and white or yellow chalk, children will illustrate their observations and then describe.
b. The position and length of shadows are determined by the position of the light source in relation to the object.	1. Children check the shadow cast by a broom handle on the ground. Check at definite intervals during the day for several days. References: C.I.S. T56 S.M.A. T35
Skills: Predicting, Communicating.	2. Read, *My Shadow,* by Robert L. Stevenson. Why is the shadow sometimes tall and sometimes small? Media: ▶◀ *Light and Shadow,* Sovereign

Concepts and Subconcepts	Suggested Activities and Instructional Materials
c. An opaque object blocks the sun's light and casts a shadow.	1. Provide students with various transparent, translucent and opaque materials. Ask them to make shadows in sunlight or in light from another source with these materials. Reference: C.I.S. T54-55
Skills: Investigating, Observing, Inferring, Predicting.	2. Children make each other's shadow portraits with a slide projector or have children pantomime animals with their fingers between a light source and screen. Capitalize on this interest to let pupils investigate what affects the size, shape, and sharpness of shadows. 3. With marbles, pencils, cubes, etc., show how different shadows may be made. Have the children predict what shape the object is from its shadow. Reference: C.I.S. T85
d. The moon shines by reflected sunlight.	1. Pupil "A" shines a flashlight on to foil paper held by pupil "B". Place a globe on a table away from direct sunlight. The class then tells child "B" which way to move the paper so that light reflects onto the globe. Why do you think the moon is sometimes called "a mirror in the sky"? Reference: C.I.S. T58-59
Skills: Observing, Predicting, Inferring.	2. If direct sunlight is available, children take turns using a mirror to reflect light from the sun on to various surfaces. Have someone hold the mirror in a darkened part of the room? Does the mirror have light of its own?

GRADE II

CONCEPTUAL SCHEME A

When energy changes from one form to another, the total amount of energy remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

wheat seeds, flower pots, wide-mouth bottles, lens, small pieces of wood, leaves, plastic dishes, bean seeds, lamp, coal, sandstone, oil, string, test tubes, washers, yardsticks, alarm clocks, tuning forks, styrofoam balls, aquarium, rulers, rubber bands, balloons, droppers, candles, copper wire, lamps, flashlight batteries, mirrors, prisms.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

▶◀	Films	⊙	Records
▶◀$_8$	Film Loops	●‿●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **The sun is our prime source of energy.** a. Green plants use and store energy from the sun.	
Skills: Observing, Communicating, Interpreting data.	1. Children plant a kernel of wheat in each of two identical containers. As soon as the shoots appear, cover one container with a brown paper bag. Each day compare the two plants. Keep a graph of plants' growth. Place the yellow wheat in the sun for a few days. What happened? What would happen to plants if there were sunlight 24 hours a day? References: C.I.S. T26, 27 S.T.W. T83-89 Media: ▶◀ *Sun's Energy*, Academy ▶◀ *Big Sun and Our Earth*, Coronet ▶◀ *How Sunshine Helps Us*, Coronet ▶◀ *What Plants Need For Growth*, E.B.F. ▶◀ *Tree is a Living Thing*, N.F.B. ▶◀ *Seasonal Changes in Trees*, Coronet.
Observing, Inferring.	2. Children place slough water in two wide-mouth jars. Place one in sunlight, keep the other in the shade. What differences are noticed after a period of a week or two? (Green algae appears in jar in sunlight.) Observe green plants with lens.
2. **Chemical energy can be changed to light energy and heat energy.** a. When a fuel burns, energy is released.	
Skills: Observing, Inferring, Formulating models, Defining.	1. Teacher burns a small piece of wood — the **fuel.** What do you see happening? (Heat and light given off). Emphasize that energy came from sun — wood (plant) where it was stored — burned (light and heat). References: C.I.S. T89-93, T26-27 S.T.W. T90-93
Inferring, Formulating models, (energy change), Defining terms.	2. Have children burn dry leaves and stems. What is the black substance? (**Carbon**). Where did the energy (heat and light) come from for the fire? Trace the energy change: sun's energy — energy stored in plant — light and heat energy from burning. References: C.I.S. T28, T29 S.T.W. T123-124, T130
3. **Energy can be transferred from one place to another.** a. Energy can be captured from the sun and stored in green plants.	Reference: C.I.S. T30-31

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Observing, Interpreting data, Quantifying.	1. Place a piece of paper towel in the bottom of a plastic dish. Add water until the paper is just covered. Place four bean seeds in the dish. Cover them with a piece of damp paper towel and leave seeds to germinate. When they start to germinate cut away half of the cotyledon in two seeds. Be careful not to damage the embryo. Plant the seeds with full cotyledons in one pot, and the other seeds with half cotyledons in another pot. Water carefully. How long did the plants in each pot grow? Why did they stop growing in one pot before the other? (Emphasize that in one pot the seeds had no more stored food.)
b. When a fuel burns, energy is released.	
Skills: Observing.	1. Have children discover there is carbon in oil when lampblack collects on a piece of glass. Also, there is carbon in candle. This carbon can be collected on a plate. Reference: C.I.S. T32-33
Inferring, Developing model.	2. Burn a piece of coal. What energy was produced? Where did the coal come from? Where did the plants get their energy?
Classifying.	3. Begin a collection of carbon and things that contain carbon.
c. Oil is a fuel which contains energy that was captured from the sun and stored by green plants.	
Skills: Observing, Inferring, Formulating models.	1. Put oil on sandstone. What happens? Put oil on glass. Emphasize that the oil in the earth is in porous rock. Fill a small plastic vial with marbles. Is the jar really full? Then have the pupils pour water into the jar to show that the jar was not full. Pour out half of the water. Pour in oil; place cap on vial and turn upside down. What happened? Why does the oil stay on the top? Reference: C.I.S. T34-35
d. Gas is a fuel which contains energy that was captured from the sun and stored by green plants.	
Skills: Inferring, Formulating models.	1. Make a model of an oil well using marbles, oil, water, and plastic vials. Trace the transfer of energy; sun's energy—plants — animals — fuels. Why is the aid (the gas) on top, the oil in the middle, and the water on the bottom? What is the difference between gas and gasoline? Reference: C.I.S. T36, T37
4. **Energy can be transferred through the molecules of solids, liquids and gases.**	
a Sounds are made in different ways.	Media: ⋈ *Sound and How it Travels*, E.B.F.
Skills: Observing, Experimenting.	1. Children are given a number of objects such as string, test tube, washer, etc. Have them find ways that sounds may be produced; for example, blowing over test tube's open end, tapping washer, plucking string, dropping water into a pail with a dropper, etc. References: C.I.S. T40-45, T54-55 S.M.A. T64, T69-71, T94-95
5. **Sound is a transfer of energy through the molecules of solids, liquids and gases.**	
a. Sound is a result of vibration (energy motion).	
Skills: Observing (seeing, hearing, and touching), Formulating models.	1. Children find that various states of matter can carry sound: (a) Place one end of yardstick on your head and the other end on ringing alarm clock. Can you feel the **vibration?** Reference: S.M.A. pp. 100-102, 104, 109 b) Tap a tuning fork on something solid, then place fork on side of head. What do you observe? Place a vibrating tuning fork into a glass of water. What happens? What happens to a styrofoam ball when touched with the vibrating tuning fork? Why?

References: S.M.A. T68 - pp. 101-102

c) Tap on the side of an aquarium. Do the fish move? Why?

d) Why is it we can hear sounds through air?

Bring out the idea that a solid, liquid or gas must be vibrating in order for sound to be produced and that sound is a form of energy.

6 **Sounds vary in pitch. They may be high or low.**

a. The greater the frequency of vibration, the higher the pitch of sound.

Skills: Observing, Interpreting data

1. Let about 9″ of a 12″ wooden ruler hang over the edge of desk. Hold the short end firmly and snap the end that extends over. What kind of sound do you hear? Can you see the ruler extend beyond the desk? Snap the end again. What do you observe? Describe the sound you hear. How is it different from the first sound?

References: C.I.S. T46 S.M.A. T64-67, T69
S.T.W. T4

Media: *Finding Out About Sound,* S.V.E.

Observing, Interpreting data, Defining terms.

2. Children pluck thick, thin, short and long rubber bands, etc., and compare **pitch.** When do we get high sounds? When do we get low sounds?

7. **Sounds travel through solids, liquids or gases.**

a. Sound travels in a wave pattern through molecules of solids, liquids or gases.

Skills: Observing, Formulating models.

1. Drop a washer into a dish filled with water. What do you observe? Emphasize that **we think** this is the way sound waves travel.

References: C.I.S. T47-49 S.M.A. T71

2. Place a vibrating tuning fork on the surface of water. What do you observe?

3. Pupils draw picture (model) of how we think sound travels.

4. Do sounds travel fastest in solids, liquids or gases? How could we find out?

8. **Sound travels through solids, liquids and gases.**

Media: *Sounds We Hear,* S.V.E.

a. Speech is the result of sound patterns made when the vocal cords vibrate molecules of air.

Skills: Observing, Interpreting data, Controlling variables, Formulating models.

1. Blow up a balloon. Hold each side of the neck of the balloon with the thumb and forefinger of each of your hands. As the air goes out of the balloon, pull on each side of the neck of the balloon. What happens as you stretch the neck of the balloon?

Reference: C.I.S. T50

9. **Sound waves travel through molecules of solids, liquids or gases.**

a. Sound waves may be reflected.

Skills: Observing, Inferring, Predicting.

1. Pupils drop a small washer into a plastic dish of water. Note the size of the waves. Drop a large washer into the same container. Are the waves the same size? What happens to the waves when they strike the side of the container?

References: C.I.S. T51 S.M.A. T69-70, p.105

2. Visit the auditorium or gymnasium to experiment with the formation of echoes. (Must be 55 feet long.)

Concepts and Subconcepts	Suggested Activities and Instructional Materials
10. **Sound is a transfer of energy in a wave pattern through molecules of solids, liquids or gases.**	
a. Hearing is the result of a transfer of energy through sound vibrations.	
Skills: Observing, Inferring.	1. See investigations and discussions in textbooks. References C.I.S. T52-53 S.M.A. T71-72, pp. 110-113
b. Sound does not travel through a vacuum.	References: C.I.S. T55 S.M.A. pp. 106-109
Skills: Observing, Inferring.	1. If a bell jar and pump are available, get an alarm clock ringing and then exhaust the air. Why can't we hear the alarm ringing? Reference: S.M.A. T71
Formulating hypothesis.	2. Initiate discussion by asking the children what would happen if the earth had no air? What would we hear?
11. **Light is a form of energy.**	Media: *Electricity: To Make a Circuit,* E.B.F.
a. Chemical energy can be converted to light energy.	
Skills: Observing, Inferring.	1. Children light a candle and observe. What keeps the candle burning? Reference: C.I.S. T58-59 2. Light a match. Then light a second one. What do you observe? Emphasize that the energy in the wood is being changed to light energy and heat energy.
b. Electric energy can be converted to light energy.	Reference: C.I.S. T60-61, T62-63, T64-65
12. **Matter on the sun is converted to energy including light energy.**	Media: *Light and How it Travels,* J.H.
Skills: Experimenting, Inferring. Observing, Inferring.	1. Give the pupils a lamp, copper wire and flashlight battery and ask them to see if they can make the lamp light. Where is the energy coming from to light the lamp? If old batteries are available let the pupils: a) examine the inside of a battery, b) bare a piece of insulated wire and have one end contact the bottom of a flashlight battery and rub the other end across the terminal. What do you see?
13. **Light is a form of energy.**	
a. Light travels in a straight line.	
Skills: Defining terms, Interpreting data.	1. Have pupils examine the parts of a flashlight. In a slightly darkened room stand a ruler upon end and shine a flashlight on it. Examine the shadow. Let pupils move the flashlight around to different angles. References: C.I.S. T67 S.T.W. T74-75 2. Place a light in front of a straight drinking straw. Observe the straw. What happened? Why? How is light different from sound?
b. Light may be transmitted, reflected, bent or absorbed.	
Skills: Classifying.	1. Pupils collect various kinds of materials. Find out which ones are transparent, which translucent and which opaque. References: C.I.S. T68-72 S.M.A. T75
Classifying.	2. Reflect light from a mirror at different angles. Develop model for reflected light by comparing to a bouncing ball. Bounce a ball at various angles.
Observing, Interpreting data.	3. Place a pencil in a tumbler of water. What do you see?
14. **Light is a form of energy transferred as a wave.**	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Interpreting data.	1. Discuss sound waves. How are light waves the same? How are they different? (Light waves don't spread out.) Reference: C.I.S. T70-71
15. (Optional) **Sight is a psychological response to the stimulus of light energy.** a. The eye receives light and transmits light sensation.	References: C.I.S. T73 S.T.W. pp. 130-133
b. Light may be separated into the colors of the spectrum.	Media: ⊟ *Light, Heat and Sound Review,* S.V.E.
Skills: Observing, Communicating.	1. Use a prism to break up a beam of sunlight. Record the colors on a chart in the order in which they appear. References: C.I.S. T-74-75 S.M.A. p. 129 2. Compare the colors in the spectrum from sunlight with those from a projector. 3. Can you develop a theory that might explain why the white light comes out of the prism in various colors?

GRADE II

CONCEPTUAL SCHEME B

When matter undergoes a chemical change, the total amount of matter remains unchanged.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

▶◀ Films
▶◀8 Film Loops
⊟ Filmstrips
⊙ Records
●_● Tapes
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Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **A molecule is the smallest part of a substance which retains the chemical properties of that substance.** a. Although molecules are too small to be seen, they may be detected by other methods.	
Skills: Observing.	1. Set the stage for a discussion of molecules by spraying some perfume into the air in the classroom while the children are out of the room. How do we know there is perfume in the air? How do you know when your mother is cooking onions? How do we know when something is cold, smooth, sour, etc.? References: C.I.S. T2, T3 S.T.W. T1-29
b. Molecules are too small to be seen, but substances can be detected by the sense of smell.	
Skills: Observing (smelling).	1. Collect foods with distinctive odors and tastes — see references. Blindfold students. Students identify food by smell. Reference: C.I.S. T4
c. Some substances may be detected by taste.	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Observing (tasting).	1. Pupils observe a cube of sugar. Observe a cube of sugar with a magnifying lens. What do you see? Grind up the lump of sugar. Examine a grain under a magnifying lens. Place some sugar in water. Can you see the sugar? How do you know its there? Place a drop of sugar water on a glass slide. Leave for a few minutes. Observe with a magnifying lens. What do you see? Where did the water go? Where did the sugar come from? Reference: C.I.S. T5
d. Molecules of one substance can be diffused with molecules of another.	
Skills: Observing, Quantifying, Predicting, Inferring, Defining terms.	1. Investigation with two identical pieces of cloth balanced on the ends of a ruler and suspended from a rod (yardstick). Wet one cloth — observe — discuss. Leave until water evaporates, observe again. Reference: C.I.S. T6
Observing, Quantifying, Inferring.	2. Place one end of a blotter in a dish of water. Leave for a few minutes. What do you see? Did the water lower in the dish?
e. Molecules of one substance may be evenly distributed (dissolved) through molecules of another.	
Skills: Observing, Inferring.	1. Dissolve sugar in water. Pour water (solution) through cotton. Taste. Place a drop of salt water on a slide. Leave for a few minutes. Observe with a magnifying lens. What do you see? Where did the water go? Where did the crystals come from? What do they taste like? Reference: C.I.S. T7
Observing, Inferring, Formulating models.	2. Have pupils observe a bottle of pop. Take off cap. What do you see? (Bubbles coming out of pop.) Where did the bubbles come from?
f. The motion of molecules determines the state of matter (solids, liquids, gases).	Media: *What Makes Rain?* *Finding Out About Heating Solids, Liquids and Gases,* S.V.E. *Finding Out How Things Change,* S.V.E.
Skills: Classifying.	1. Pupils classify the following as solids, or liquids: steel balls, pencil, beans or other seeds, candle, ruler, syrup, milk, bottle of soda pop. References: C.I.S. Bk.1 T30-41 S.T.W. pp. 57-92 T37-58
Observing, Inferring.	2. Have pupils observe a small bit of paraffin wax. Then place it in a test tube and heat gently. What happened? Why? (Develop idea that additional energy was supplied.) Try to develop a theory.
Observing, Interpreting data.	3. Have pupils put one end of a drinking straw into a tumbler of water and blow gently through the other end. What is causing the bubbles? Reference: C.I.S. T8
Hypothesizing.	4. Blow up a balloon. Feel the balloon. Why does the balloon stretch? Is there anything inside? Immerse its neck in water and let some air escape. Are the bubbles solid? Liquid? Introduce the term **gas.**
Observing, Classifying, Communicating.	5. Scoop air into a plastic bag. Feel the bag. How is it different from the solids and liquids?
Formulating models.	6. Develop models for: — solids by fastening styrofoam balls together so that they are rigid. — liquids by placing styrofoam balls in containers of different shapes. Can molecules move around? — gases by placing a few styrofoam balls in a container and shake.
g. Every substance has its own particular molecular structure, which is determined by the kinds, number and arrangement of atoms within a molecule.	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Formulating models.	1. View chalk dust and grains of sugar through a magnifying lens. Develop idea that each speck contains millions and millions of molecules. Using styrofoam balls, make model of water molecule. Some pupils may make C molecule. Reference: C.I.S. T9-11
h. Evaporation results when molecules gain enough energy to move apart from one another.	Media: *Wind,* E.B.F. *Air and What It Does,* E.B.F. *Air Around Us,* E.B.F.
Skills: Observing, Inferring.	1. Moisten cotton batting with alcohol. Wipe some alcohol on the back of the hand. What did you observe? Why did the heat go? Where did the alcohol go? Reference: C.I.S. T12-13
Formulating models.	2. Investigations with wet cloth, water in glass, and mothballs to show that molecules break away and move apart into the air. Construct models to show liquid, then what happens when evaporation occurs.
2. Heat energy causes water to expand. a. Expansion exerts a force that can be used to do work.	
Skills: Observing, Communicating, Inferring, Predicting.	1. Fit a piece of glass tubing tightly into a rubber stopper. Insert into a test tube full of water so that the water comes part way up the tube. Mark the level of the water with a piece of tape. Heat. What happened? Why? References: C.I.S. T16-17 S.T.W. T119-120
Observing, Communicating, Inferring, Predicting.	2. Make a steam generator that will turn a turbine. Is work being done? Trace the energy changes. Media: *What is Heat?,* J.H. *Heat Changes Things,* J.H. *Where Do We Get Heat?* J.H. *Heat Makes Things Expand,* J H. *Air All Around Us.*
3. Heat energy causes air to expand. a. Expanding air can exert a force to do work.	
Skills: Observing, Interpreting data.	1. See activity page T118, S.T.W. Emphasize that force of expanding air is lifting balloon. References: C.I.S. T18-19 S.T.W. T118
Formulating models.	2. Place a rubber stopper into the end of a test tube. (To be done by teacher only.) Heat gently. What happened? Why? Was work done?
b. Heat energy can be transferred from one place to another in molecular collisions.	Media: 8mm Films: (Single Concept) *Air Has Weight,* FE 1-0 *Air Pressure,* FE 3-0 *Air Occupies Space,* FE 2-0 *Heat Travel,* J.H.
Skills: Interpreting data.	1. Heat one end of a six-inch piece of base copper wire while the other end is held between fingers. What happens in a few minutes? Why? References: C.I.S. T20-21 S.M.A. T89-90 S.T.W. T121-122
Formulating models.	2. Using rubber balls between two meter sticks, show how heat is carried along the wire by collisions.
4. Heat energy causes matter to expand. a. The greater the speed of the molecules, the greater the temperature of the body.	
Skills: Observing, Quantifying, Interpreting data.	1. Place a drop of ink into two identical tumblers of water. Heat the one tumbler. What do you observe about the solutions at the end of five minutes? Measure their temperatures.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
b. Expansions result when molecules move faster. Skills: Observing, Inferring	Media: ⊟ *Thermometers and How They Work,* ⊟ *Reading a Thermometer.* 1. Observe thermometers in sun and in shade. Note changes at end of each minute. References: C.I.S. T23 S.M.A. T84-90 S.T.W. T121, T117 2. Investigation with nail and washer and with copper wire stretched taut and then heated. Reference: C.I.S. T19

GRADE II

CONCEPTUAL SCHEME C

Living things are interdependent with one another and with their environment.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

- ⧓ Films
- ⧓$_8$ Film Loops
- ⊟ Filmstrips
- ⊙ Records
- ●_● Tapes
- [ ] Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Living things depend for their energy on a flow of materials from the environment.**	Media: ⧓ *Finding Out About Green Plants,* S.V.E. ⧓ *How Plants Live,* E.B.F. ⧓ *Plant Needs,* E.B.F. ⧓ *Where Green Plants Grow,* J.H. ⧓ *How Green Plants Grow,* J.H. ⧓ *Plant Life in the Desert,* E.B.F. ⧓ *Plant Factories,* S.V.E.
a. Living things are specially adapted to a special environment. Skills: Observing, Classifying, Communicating, Inferring, Predicting, Formulating hypotheses, Controlling variables.	1. Have pupils make: — individual water plant gardens (pupils may get pond plants or purchase aquarium plants) — individual desert plant gardens — individual wood plant gardens — individual land plant gardens. 2. Transfer one plant of each kind from its natural environment to a different garden. Observe results.
b. Classification of living things is based on characteristics held in common within the group. Skills: Classification.	Media: ⧓ *A Balanced Aquarium,* E.B.F. 1. As a basis for later work on classification have pupils classify themselves on basis of such things as sex, eye color, age, attached or unattached ear lobes, etc. References: C.I.S. T176-184 S.T.W. T20-25
Observing, Interpreting data, Classifying.	2. Put jar of pond or aquarium water in sunlight. Why does it become green and soupy? Observe green algae with lens or microscope. How are algae different from other green plants? Compare algae with bean plant. How are they alike? How are they different? References: C.I.S. T176-177 S.T.W. T30
Classifying, Interpreting data.	3. Start a hay infusion two weeks prior to the time you will need microscopic animals. Compare small life (amoeba, euglena, etc.) found in hay infusion to an animal such as a cat. How does each move? How does each eat? Where does the food for each come from? How are animals different from plants?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Interpreting data, Hypothesizing, Experimenting.	4. Show pupils a mould you have grown. Is this a plant or animal? It doesn't look like a plant (confrontation). How do you know it is? Where does it get its energy to make it grow? Children put moistened bread in a bottle with a loose lid. Leave grapes, cut apple, orange, etc., in warm, damp place. A plastic bag is good for this. Let children watch mould grow. Children might investigate. What conditions are best for growing mould? View spore cases and spores under a microscope or double lens. Reference: S.T.W. T104 Media: ⊟ *The Parts of a Plant* ⊟ *How Seeds Are Scattered* ⋈ *How Trees Grow*, P.D.P. ⋈ *Plants We Use*, E.B.F. ⋈ *Green Plants Are Important To Us*
Observing, Classifying, Interpreting data.	5. Have pupils examine mushrooms. Children examine spores under microscope. Study pictures and material on bacteria, fungi and yeast. References: C.I.S. T178-184 S.T.W. T102-103
Observing, Classifying.	6. Examine seed plants with aid of hand lens. Do all seed plants have flowers? (Conifers don't.)

GRADE II

CONCEPTUAL SCHEME D

Living things are products of their heredity and environment.

SUGGESTED MATERIALS AND EQUIPMENT

Seeds: beans, grass, corn, wheat; magnifying glasses; sand; soil; plant food (concentrate); plant growth medium; plastic flower pots; thermometers; polythene dishes.

SUPPLEMENTARY REFERENCES

Craig, Gerald, *Science for You — Book 2*, Toronto: Ginn and Company, 1965.

Elementary Science Study, *Teacher's Guide to Growing Seeds*, Toronto: McGraw-Hill Co.

Code for Media:

⋈	Films	⊙	Records
⋈$_8$	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Code for References:

C.I.S. — *Concepts in Science*, Longmans.

S.M.A. — *Science, A Modern Approach*, Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **An organism is a product of its heredity.**	
a Grass plants reproduce by seeds. Skills: Observing, Classifying, Inferring, Predicting.	1. Examine outside of seeds (lawn grass, corn and wheat) with a magnifying lens. What shape are they? What color? 2. The teacher should grow some grass plants in advance of the lesson (e.g., lawn grass, corn and wheat). Show the pupils seeds for each of the plants grown. See if they can classify the seeds which will grow grass; which will grow corn; and which will grow wheat. Are seeds alive? References: C.I.S. p. 78 S.T.W. p. 86 Media: ⋈ *Learning About Seeds*, E.B.F., TK-2221 ⊟ *New Plants from Seeds*, Jam Handy 3. Have pupils plant grass, corn and wheat seeds. Were our predictions correct? (Plant bean seeds at the same time for Subconcept b.)
b. Plants belonging to the same family have common characteristics.	1. Have children compare grass (timothy if available), corn, wheat and bean plants. How are the grass, corn and wheat plants alike? How are they different from the bean plants? Reference: C.I.S. p. 81

Skills: Observing, Classifying.	
2. **The life and growth of a plant are affected by its environment.**	
a. Green plants make their own food (after they have used the food in the seed for their first growth).	1. What is in a seed? Have ready many bean, pea and corn seeds that have been soaked in water overnight. Let each child open one seed of each kind. Examine with magnifying glass. Find small plant inside seed; find food for small plant. References: C.I.S. p. 80 S.T.W p. 90
Skills: Observing, Communicating, Inferring, Predicting.	
b. Water, air and sunlight are essential to the growth and development of plants.	1. After the food in seed is used, where does the plant get more food? Use plants grown in previous investigations. By using paper strips, quantification and graphing may be introduced. References: C.I.S. pp. 81, 82, 83, 84 (Do experiments) S.T.W. pp. 91, 92, 93, 94 (Do experiments)
Skills: Observing, Quantifying, Controlling variables.	Media: ⋈ *What do Green Plants Need for Growth?* J.H. ⋈ *How do Green Plants Grow?* J.H. ⊟ *Plant Factories* S.V.E., PK-3488 ⊟ *Plants and More Plants,* S.V.E ⊟ *Where do Plants Grow?* J.H. ⊟ *How Plants Start Growing,* E.B.F.
3. **An organism is a product of its heredity and environment.**	
a. Seed plants are complex organisms. Each has a special function.	1. Have pupils observe roots of plants grown. What do roots do? What if a seed plant had no roots? 2. Examine other parts of a plant. What does each part do? What if the plant did not have each part?
Skills: Communicating, Inferring.	References: C.I.S. pp. 85-92 S.T.W. pp. 86-89, p. 93 Media: ⋈ *Learning About Seeds,* E.B.F., TK-2221
b. Seed plants are complex organisms, having special adaptations to a land environment.	1. Go for a walk. Observe evergreen trees. Do evergreens have flowers? Where are the seeds to grow other evergreens? Take cones to school. Take off scales. Find two seeds on each scale. Observe under microscope. Reference: C.I.S. pp. 86-92
Skills: Observing, Communicating, Inferring.	2. Do all new plants start from seeds? Some plants may be grown in other ways. (tulips, daffodils, onions from bulbs; geranium, begonia and ivy from cuttings). Reference: C.I.S. pp. 98-100 Media: ⊟ *Finding Out About Seeds, Bulbs and Slips,* S.V.E. ⊟ *New Plants From Older Plants,* S.V.E.
Observing, Communicating, Predicting, Classifying.	3. How do potato plants start? Where does the piece containing the eye grow best? Why? Reference: S.T.W. p. 101
c. Seeds of plants are distributed in various ways.	1. A short field trip in the fall would be useful here to see seeds being carried by air — parachute type, bursting pods, water-float, land-animals. Reference: S.T.W. pp. 96-97
4. **There is an interchange of material and energy between organisms and the environment.**	
a. Plants are directly or indirectly the source of all food for man and other animals.	1. Request pupils to think of all foods they ate at their most recent meal. (breakfast or lunch). List each food.
Skills: Communicating, Classifying.	2. Which foods came from — a) animals? b) plants? Reference: C.I.S. pp. 94, 95 Media: ⊟ *Green Plants are Important to Us,* J.H.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Formulating models. Communicating, Classifying, Inferring.	3. Introduce pupils to food chains (e.g., man-egg-chicken-grain-sun). 4. For subsequent lessons, bring from home well washed cans, cartons, and packages that contained food. Leave labels on. Reference: C.I.S. pp. 97-118 Media: ⋈ *A Balanced Aquarium,* E.B.F. ⊟ *Where Green Plants Grow,* J.H. Decide which is: food from roots, stems, leaves, flowers, fruits, seeds, animals. Recall that plants are the food that the animals ate. Media: ⊟ *Plants We Know,* S.V.E. ⋈ *Planting Our Garden,* E.B.F.
b. All organisms depend on food substances for energy and growth. Skills: Observing, Classifying, Inferring.	1. Bring pets to school. Feed them proper food. Observe and classify. Develop the idea that animals that are not pets must live where they can find their natural food. References: C.I.S. pp. 119-124 S.M.A. pp. 7-53 Media: ⋈ *Care of Pets,* E.B.F. ⋈ *How Animals Live,* S.V.E. ⋈ *Animals as Pets,* S.V.E. 2. Grow some plants in water without minerals. Grow others in water with minerals Compare growth of the two. Which will grow the fastest? Compare by measuring and recording the growths of plants in water only and in water with minerals.

GRADE II

CONCEPTUAL SCHEME E

Living things are in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

fossil kit, plants (bean or other).

SUPPLEMENTARY REFERENCES

MacCracken, Helen. *Science Through Discovery 2.* Singer Science Series, L. W. Singer Co., Don Mills, Ontario: J. M. Dent, 1967. (A very good teacher and pupil reference for this conceptual scheme).

Code for Media:

⋈	Films	⊙	Records
⋈8	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Code for References:

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S.M.A. — *Science, A Modern Approach,* Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World,* Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Plants and animals have changed over the years.**	
a. Fossil records provide evidence of prehistoric life. Skills: Observing, Inferring, Interpreting data.	1. Use fossil kit to introduce study of life in the past. Reference: C.I.S. T149-166 2. Drop an insect in oil. Leave another outside of the oil. Compare the two at various intervals — after 1 day, 3 days, 1 week. Media: ⊟ *Finding Out How Things Change,* S.V.E 3. Discuss deep-freezing.
b. Changes in environment affect the life, growth and development of organisms. Skills: Observing, Inferring, Classifying.	1. Investigate the effects of freezing on plants by placing bean plants in a freezer or outside in winter. 2. Compare pictures in C.I.S. with plants living today.

GRADE II

CONCEPTUAL SCHEME F

The Universe and its component bodies are constantly changing.

SUGGESTED MATERIALS AND EQUIPMENT

desk lamp, globe, basketball, thermometers, mirrors, flashlight.

SUPPLEMENTARY REFERENCES

MacCracken, Helen, *Science Through Discovery 2*, Singer Science Series, Don Mills, Ontario: J. M. Dent, 1967. (A good teacher and pupil reference for this conceptual scheme).

Code for Media:

⋈	Films	⊙	Records
⋈8	Film Loops	●—●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Code for References.

C.I.S. — *Concepts in Science*, Longmans.

S.M.A. — *Science, A Modern Approach*, Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Bodies in space are in constant motion.**	
a. Planets rotate on their axis. Skills: Observing, Interpreting data, Defining terms.	1. What do you do when you rotate? Write numerals 1, 2, 3, and 4 on cards. Place each card on each wall of the classroom. Have pupils stand in one place and turn around. How many walls do you see as you rotate? 2. Use a globe and a light to show rotating and its effects. What would happen if the earth did not rotate? Rotation of the moon (rotates once every 28 days). Media: ⊟ *Finding Out How Things Change*, S.V.E., PK-5255 ⊟ *Study of the Moon, Sun and Stars*, Children's Press ⊟ *Sky Above Our Earth*, Science for Beginners, PK-5195 ⊟ *Our Home, The Earth*, S.V.E., PK-5195
b. Planets move in orbits around the sun. Skills: Formulating model, Defining terms.	1. By using a model, develop concepts of **orbiting** and **revolving.** Have one student hold a lamp while another walks around the lamp holding a basketball. (Develop concept that earth rotates as it revolves around sun.)
c. The moon is the earth's satellite. Skills: Predicting.	1. Have children pretend they are riding on the moon (a satellite) around the earth. What might you see? How long would it take?
2. **The sun is the chief source of the earth's light..**	
a. The moon shines by reflected light; the motion of the moon causes it to appear differently.	1. Reflect sunlight on to a wall with a mirror. What would happen if a light film of oil were placed over the mirror? 2. Excellent investigation in S.M.A. Reference: S.M.A. T122-129 3. Have pupils look for the moon each night for a month. Make a picture record.
3. **Matter on the sun (and other stars) is converted to energy, including light energy.**	
a. Starlight, which we see, has travelled great distances. Skills: Formulating models, Observing, Quantifying.	1. Visit planetarium if possible. References: C.I.S. T138-139 S.M.A. T135 S.T.W. T110 2. Observe stars at night for star patterns — Big Dipper, Little Dipper, Orion, . . . 3. Develop concept that our sun is a star that gives off large amounts of light and heat. Have pupils feel the heat given off by a lamp. Compare with the sun. Measure and record temperature at various distances from the lamp.
4. **The universe is constantly changing; its bodies are in constant motion.**	
a. Discoveries in science are based on a partnership of science and technology.	Reference: C.I.S. T140-147
b. Man is beginning to explore the universe and its vast and many parts.	

GRADE III

CONCEPTUAL SCHEME A

When energy changes from one form to another, the total amount of energy remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

magnifying glasses, metal or pyrex pans, tissue paper, a lamp, globe, adhesive tape, modelling clay, paper flags or toothpicks, 2 outdoor thermometers, 2 yams or green plants (growing in water), potato cuttings (two eye spots per piece), soil, flower pots, healthy plants, carbon paper, paper clips, empty food cartons, boxes and cans with labels on, aluminum pie pans, plastic sponges, bean seeds, wax paper, electric iron, pinwheels — paper or plastic, radiometer, flashlight, solar radio, cooking thermometers, hot plate, tea, sugar, scissors, large box, black paper, rubber balls, knitting needles (metal), straight pins, aluminum foil.
pan of water, toy boat, pail, faucet or hose, cardboard for 8 in. circles, rubber bands, electric fan, tissue paper strips, cardboard fan, candles, safety matches, soft clay, long pencils, test tubes, 10" squares of aluminum foil, half of a ¼ lb. stick of butter, cotton string 5" long, saucer, knife, electric clock, record player, 6 flashlights to be taken apart, 6 — dry cells — 6 volt, copper bell wire, iron nail or bolt, thumbtacks, screwdriver, electromagnets, electric bells, round cardboard covers, quart milk cartons, damp sand, pebbles, an old telephone, electric wires (insulated).

SUPPLEMENTARY REFERENCES

Adler, Irving and Ruth, *Shadows,* N.Y.: John Day, 1961.

Bulla, Clyde R., *What Makes a Shadow.* N.Y.: Thos. Crowell, 1962.

Zim, Herbert S., *The Sun.* N.Y.: Morrow, 1953.

Lyon, Jene, *Our Sun and the Worlds Around It.* N.Y.: Golden Press, 1961.

Jacobson, Willard J. et al, *Thinking Ahead in Science; Exploring The Solar System; Earth Satellites; The Sun, Seasons, and Climate; Plants; *Energy to do Work; Day and Night; *Energy From the Sun,* shows how to make a **solar still,** a **solar reflector,** and a **solar heater;** *Electricity.* N.Y.: American Book Co., 1961.

Stokes, Edward J., *Physical Science Experiments.* Dansville, N.Y.: F. A. Owen Publishing Co., 1966. (Making an electromagnet and a waterwheel).

Jacobson, W. J., Lauby, C. J., Konicek, R. D., *Investigating in Science.* N.Y.: American Book Co., 1968 — Book 6 T/E "Energy from the Sun" (p. 66-83).

Smith, H. A. Blecha, M. K., Sterling, J., *Science 3.* River Forest, Illinois: Laidlaw Bros.

Branley, Franklyn. *Solar Energy.* N.Y.: Thomas Crowell, 1957.

Blackwood, Paul E., *Push and Pull: The Story of Energy.* N.Y.: Whittlesey House, 1959.

Epstein, Sam and Beryl, *The First Book of Electricity.* N.Y.: Franklin Watts, 1953.

* Excellent.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

▶◀ Films
▶◀8 Film Loops
⊟ Filmstrips
⊙ Records
●—● Tapes
[ ] Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **The sun is the earth's chief source of energy.**	
a. Light energy from the sun can be changed to heat energy.	Media: ⊟ *How the Earth's Movements Affect Us,* S.V.E., PK-4274 with record ⊟ *Plants Needs,* E.B.F., 9431 ⊟ *Parts of a Plant and What They Do,* E.B.F. 9433 ⊟ *Light, Heat and Sound,* S.V.E., 425-6 ⊟ *The Sun and Its Energy,* S.V.E., A409-3
Skills: Observing, Inferring, Communicating.	1. Use a magnifying glass in the bright sunlight to burn tissue paper. Reference: C.I.S. T5, S3
Communicating, Inferring.	2. Discuss sun cookers. Make a solar reflector or a solar still. Reference: C.I.S. S4
Communicating, Inferring.	3. Find out about solar houses. Make a solar heater. Reference: C.I.S. S5
Observing, Inferring, Hypothesizing, Experimenting.	4. Put a little water in the bottom of a test tube. Clamp the tube to a support. Place a cork lightly in the tube. Focus sunlight through a large magnifying glass on to the water.
b. Heat energy, a result of transformation of light energy, may be used to do work.	Media: ⊟ *What is Heat?,* J.H. ⊟ *Where Do We Get Heat?,* J.H. ▶◀ *Light and Heat,* Gateway ▶◀ *Energy and Work,* E.B.F.
Skills: Observing, Communicating.	1. Stand in the sun for awhile. How do you feel? Reference: C.I.S. T5

Observing, Communicating.	2. On a hot day try to cook an egg on the sidewalk. Reference: C.I.S. T5
Observing, Inferring, Communicating,	3. Place a bare foot on a hot sidewalk or on a sandy beach on a real hot day. How does it feel? Reference: C.I.S. T5, S11
c. Light and heat are two forms of energy.	
Skills: Observing, Inferring, Communicating, Interpreting data.	1. Discuss how the classroom feels when the sun has been streaming in all day. Why does it feel warm? Where does the heat come from? What happens at night and on cloudy days? Reference: C.I.S. T5, 6
d. Heat energy is the sum of all the motions of molecules in a substance.	
Skills: Observing, Inferring, Interpreting.	1. Take a cup of hot tea and a cup of cold tea. Put a level teaspoon of sugar into each, but do not stir. Wait one minute; then taste each one. Which tastes sweeter? Reference: S.M.A. T95-96, S187
Communicating, Interpreting.	2. Have pupils read pp. 184-186 of S.M.A. Let them describe Thompson's experiment and tell what his conclusions led him to believe. Reference: S.M.A. S184-186
Observing, Interpreting.	3. Watch the liquid in a thermometer when the thermometer is placed over a register. What happens? How do you explain this? Reference: C.I.S. T7
Quantifying, Interpreting data.	4. Take the temperature in the sun and the shade and compare. Explain the difference in terms of molecular motion. Reference: C.I.S. T7, S7
e. As the earth revolves around the sun, the earth receives different amounts of heat.	
Skills: Formulating models, Experimenting.	1. Use a globe and flashlight or lamp to review day and night. References: C.I.S. S8 S.T.W. S37-38
Formulating models, Experimenting.	2. Use mobile models to show the earth's positions at different times of the year. Reference: C.I.S. S10
Communicating, Inferring.	3. Discuss the types of climate at different times of the year. Reference: C.I.S. S9
Quantifying, Interpreting data.	4. Keep a record of daily temperatures at certain times of the day for a month. Reference: C.I.S. T8
f. Light energy, as it speeds up the motion of the molecules of which matter is composed, is changed to heat energy.	
Skills: Interpreting, Communicating.	1. What happens when the sun shines on a pan of water or on air? Reference: C.I.S. T8, S11-12
Interpreting, Communicating.	2. Explain why wet clothing dries in the sunshine. Reference: S.M.A. S186-188
g. Green plants use energy from the sun to make food.	Media: Transparencies: [ ] *The Seasons*, p. 13 [ ] *Day and Night*, p. 12 [ ] *Solar Energy*, p. 2 [ ] *Types of Satellites*, p. 17 [ ] *The Solar System and Space Travel*, T104 Milliken [ ] *Sun and Earth Seasons*, p. 1 from *Seasons and Living Things*, T203 Milliken [ ] *Photosynthesis*, p. 5, *Milliken Transparency Book*, T107

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Hypothesizing, Experimenting, Testing, Controlling variables.	1. Investigation with green plants. Two of four healthy plants are placed in a cupboard for a week while two are placed in the light. Reference: C.I.S. S13, T9
Hypothesizing, Experimenting, Testing, Controlling variables.	2. Investigation with green leaves and sunlight. Reference: C.I.S. T9, S15
Hypothesizing, Experimenting, Testing, Controlling variables.	3. Investigation using three plants. Reference: S.M.A. T24, S34
h. Green plants depend on energy from sunlight.	
Skills: Inferring, Interpreting.	1. Lift a stone or a board and observe the grass under it. What is it like? Explain Why. Reference: C.I.S. T10
Hypothesizing, Experimenting, Testing.	2. Do the investigation with the two foil pans each containing some water, a sponge, and four bean seeds. Place one in a dark cupboard and one in the sunlight. Reference: C.I.S. T10, S17
Inferring, Communicating.	3. Describe what the earth would look like if there were no light from the sun or what would happen if the sun were to cease shining tomorrow. Reference: C.I.S. T10
i. Animals are dependent upon green plants for food.	
Skills: Inferring, Communicating.	1. Present some empty food cartons and cans. Trace foods back to where each is made. References: C.I.S. T11, S18-21 S.T.W. S158, 159, 160
Inferring, Formulating models.	2. Make charts showing the origin of bread, milk, eggs, meat, cake, etc.
j. Animals depend on energy that is captured and stored by green plants in the form of food.	
Skills: Communicating, Investigating.	1. Think of some animals which live in dark caves, deep dark parts of the oceans, or in the ground, or in trees. What do these animals eat? Do they depend on sunlight? Reference: C.I.S. T11
Communicating, Investigating.	2. Read to verify your ideas. Reference: C.I.S. S18, 19
k. Animals and people, no matter where they live, depend on green plants.	
Skills: Predicting, Investigating.	1. Ask about animals other than those suggested above. Amphibians, reptiles, birds, mammals, insects, etc. Where does their food come from? Reference: C.I.S. T12
Inferring, Interpreting.	2. Ask about animals of long ago — dinosaurs, sabertoothed tigers, etc. Reference: C.I.S. T12
Formulating models, Investigating.	3. What about people? Make a class chart of the origin of the supper (lunch or breakfast) which a child ate the previous day. References: C.I.S. T11, S20 S.T.W. S160
l. The sun's radiant energy can be converted into other forms of energy.	
Skills: Observing, Interpreting.	1. Provide each student with a pinwheel. Ask him to examine it and show how he can make it turn: pushing, running, blowing, falling water, etc. Where did the energy come from? Trace it back to the sun's radiant energy.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
m. Light from the sun can be changed into mechanical energy.	
Skills: Observing, Inferring, Interpreting.	1. Place a radiometer in strong sunlight, or under a lighted lamp. Allow students to speculate on what is causing the spinning. Move the radiometer in and out of a sunny spot. When does it spin fastest? Pass a cardboard sunshade back and forth over it. Why does it stop spinning? Reference: C.I.S. T13, S22
n. Energy from the sun can be changed to heat energy.	
Skills: Observing, Inferring, Interpreting.	1. Observe the water in the fish bowl day after day. What is happening? What kind of energy makes it happen? Where does the energy come from? Reference: C.I.S. S28
Inferring, Interpreting.	2. What happens if you lie out on the beach too long? What kind of energy causes the burn? Where does the energy come from?
Predicting.	3. What causes a snowman to melt? Reference: C.I.S. S29
o. Energy from the sun can be changed to other forms of energy, including electrical energy.	
Skills: Communicating, Interpreting.	1. Ask students to describe the kinds of radios to which they listen. Where does the energy come from to make our radios play? Reference: C.I.S. T13
Predicting, Interpreting data.	2. If no persons mention a radio with solar cells, ask them to find out about this new kind of radio. What makes is play? Where does the energy come from? What enables the radio to use energy right from the sun? Reference: C.I.S. T13, S23-24
Predicting.	3. Where is it very important to be able to use energy right from the sun? (In space). Reference: C.I.S. T14
Communicating, Investigating, Interpreting data.	4. Students report on Telestar and Vanguard I, telling what they do and where they get their energy. Reference: C.I.S. S25-26
2. **Energy can be changed from one form to another.**	Media: *Kinds of Energy,* McGraw-Hill *Man's Search for Energy,* McGraw-Hill *Light, Heat and Sound,* S.V.E., #6 *What is Magnetism?,* J.H., #5 of 1075 *Magnetism and Electricity,* S.V.E., 425-5 *Understanding Electricity: Electromagnets and How They Work,* J.H., PK-3602
a. To cause movement energy is required.	
Skills: Inferring, Experimenting.	1. Place a pan of water on the floor. When the water is completely still, put a toy boat on it. How can we make the boat move without touching or blowing on it? Reference: T20-21, S33
b. Water in motion has kinetic energy which can be used to do work.	
Skills: Observing, Experimenting.	1. Make moving water turn a wheel as outlined in the investigation. Reference: C.I.S. T21, S34
Inferring, Communicating.	2. Relate this experience to the old fashioned mill. Reference: C.I.S. S36
Inferring, Communicating.	3. How is the energy of moving water used in big dams? Reference: C.I.S. S37-40

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Interpreting results.	4. Arrange a class to visit a dam. Media: *Finding Out How Foods Are Used in Your Body,* S.V.E. *Electromagnets,* McGraw-Hill, PK-3861 *Using Electricity Safely,* J.H., PK-3604 *Finding Out How Foods are Used in Your Body,* S.V.E., A424-19 *Energy At Work,* E.B.F. *Wind and What it Does,* E.B.F. *Energy Does Work,* C.F. *Electricity. How to Make a Circuit,* E.B.F. *Electromagnets,* McGraw-Hill
c. Energy from the sun is transformed to heat energy which makes air move.	
Skills: Observing, Predicting, Interpreting.	1. Do the investigation outlined in C.I.S. using moving air. Reference: C.I.S. S44
Observing, Interpreting.	2. Observe tissue strips held in a current of rising air.
d. The kinetic energy of moving air (wind) is used to do work.	
Skills: Interpreting data.	1. What causes winds?
Interpreting data.	2. What makes the air move?
Communicating.	3. List the different ways in which wind helps us. Reference: C.I.S. S41-43
Formulating models.	4. Collect pictures of wind helping us.
e. Chemical energy stored in fuel can be released by burning.	
Skills: Observing, Inferring, Predicting.	1. Pupils examine unlit candles. Is there any energy in them? Give reasons for your answer. Light candles. Feel the heat and light. What has happened? Reference: C.I.S. T24
f. Released energy can make things move — hence do work.	
Skills: Following instructions.	1. Do the investigation suggested on page 48 of C.I.S. Reference: C.I.S. S48
Observing, Interpreting.	2. Obtain some Christmas Angel Chimes and observe what happens when the candles are lighted. Reference: C.I.S. S49
g. Fuels give off heat and light energy when they burn.	
Skills: Observing, Classifying, Inferring.	1. In the above investigations what kind of energy warmed the air? What two kinds of energy do we get when a candle burns? What had to happen before the energy was given off? What happens when the candles are blown out? Reference: C.I.S. T25, S49
h. Energy is stored by plants and animals that grow in the sunlight.	
Skills: Predicting, Communicating, Hypothesizing, Questioning.	1. Do you make energy when you burn a candle? How is energy stored in the wax of the candle? Why do scientists **think** that petroleum comes from the plants and animals of long ago? Why aren't they sure? Reference: C.I.S. T26, S50-52
i. Food (like fuel) has stored (potential) energy. Stored energy in food changes to other forms of energy.	
Skills: Observing, Inferring.	1. In what way are we like automobiles?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Inferring, Interpreting.	2. Take your temperature. Why is it warmer than the room around you?
Observing, Inferring.	3. Breathe on your hand. Is the air warmer or cooler than that around you? Where does the heat in your body come from?
	References: C.I.S. T27, S54 S.T.W. T158-159
Observing, Predicting.	4. Burn a butter candle **or** place a shelled peanut on a wire; hold heat under it. Hold a plate over the flame. What is on it? What color are the remains?
	Reference: C.I.S. S55
j. Energy from food may be used by the body for growth and to do work.	
Skills: Quantifying, Hypothesizing.	1. Were you once much smaller than you are now? Will you someday be bigger? What makes you grow?
	Reference: C.I.S. T27
Communicating, Observing.	2. Discussion — Will you someday stop growing completely? Will some parts of you keep on growing or changing even when you are big?
	Reference: C.I.S. T28
Observing, Hypothesizing.	3. Think of all the moving your body does in a day. Does it do any moving while you sleep? What helps you move?
	Reference: C.I.S. S56, 57
Communicating, Classifying.	4. Make a collection of pictures of good energy foods.
	Reference: C.I.S. S58
k. Stored chemical energy in a dry cell can be changed to electrical energy.	Media: From Milliken Transparencies T106: [ ] *Electric Current and Magnetism,* p. 6 [ ] *Electro-Magnets,* p. 7 [ ] *Wet and Dry Cells,* p. 12 [ ] *The Pathway of Electricity Circuits,* p. 15 [ ] *Switches and Fuses,* p. 17 [ ] *Kinds of Magnets,* p. 1
Skills: Observing, Predicting, Experimenting.	1. Allow students to study flashlights. How do you turn them on? Study the bulbs. What are they like? Where is the electricity coming from? Take the flashlight apart. Study the parts. Which part supplies the energy? How can you prove your answer?
	Reference: C.I.S. T29, S60
l. Electric energy can be used to make things move (to do work).	
Skills: Observing, Inferring.	1. Take a record player, an electric clock, or a closed electric fan. How can you make these move? Where is the energy coming from?
	Reference: C.I.S. T28
Predicting, Experimenting.	2. Do the investigation from C.I.S. page 61. How can you make the electromagnet stronger?
	Reference: C.I.S. S61, 62, 63
Observing, Classifying.	3. Take an old telephone or electric bell apart. Look for the electromagnet.
m. Electric energy flows through a circuit.	Reference: C.I.S. T32
Skills: Observing, Making operational definitions, **(circuit),** Hypothesizing.	1. Study an electric bell. Find the turns of wire. Make an electric bell ring by connecting it to a dry cell. Explain what is happening. What happens if you unfasten one wire?
	Reference: C.I.S. T31-32, S64, 65, 66
Formulating models.	2. Make a light switch.
Classifying, Quantifying.	3. Make a collection of electric light cords, insulate outdoor electric wire, plugs, sockets, switches, etc., for an exhibit.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
n. Energy of motion (as resulting from electric energy) can be used to do work.	
Skills: Formulating models, Experimenting.	1. Make and use an electric motor. Reference: C.I.S. T32, S67
Observing, Classifying, Communicating.	2. Investigate at home and report which of the following have electric motors: an electric clock, an electric razor, an electric beater, a toaster, and an electric toothbrush, etc. Reference: C.I.S. S69

GRADE III

CONCEPTUAL SCHEME B

When matter changes from one form to another, the total amount of matter remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

weighing scale, large plastic jar, ice cubes, pyrex cooking pan, electric grill, thermometers, rubbing alcohol, vinegar, mouthwash, after-shave lotion, vanilla, lemon extract, wads of absorbent cotton, perfume (colored), mothballs (12), large glass bottles, glasses (tumblers), baking soda, dry ice (several pieces), tongs, sugar (lump — 1 lb.) (granulated — 5 lb.) (powdered — 1 lb.), salt — 1 container, glass jars, teaspoons, measuring cups, atom models, clean water, metal cooking pans, shallow pans, cotton string, clean bolts or screws, rulers, magnifying lenses, plastic jars (6), black paper, metal pie pans, hot dish holders, 1 box cornstarch, 10 pennies, iron filings, sheets of paper (12), magnets (7-12), carbon, pint milk cartons, paper napkins, large nails, clean sand, coffee grounds, instant coffee, cocoa, powdered chalk, dry milk, cinnamon, etc., scissors, silver spoons, hard-boiled eggs, silver polish, writing paper, rocks (small pieces), aluminum, zinc, copper, iron, iodine, mercury, nickel, milk, vinegar, instant tea, toothpicks, gumdrops, dextrose, powdered starch, copper sulfate, filter paper.

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S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)

S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⋈	Films	⊙	Records
⋈8	Film Loops	●—●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1 **Matter consists of atoms and molecules.**	Media: ⊟ *All Matter Has Three Forms,* Y.A.F. ⊟ *Finding Out About Heating Solids, Liquids and Gases,* S.V.E. ⊟ *Some Things Dissolve,* McGraw-Hill ⊟ *Understanding Chemical Change,* McGraw-Hill
a. In physical change, such a change of state, the amount of matter taking part remains unchanged.	
Skills: Observing, Predicting, Quantifying, Interpreting.	1. Melt ice and compare weight of water as a solid and as a liquid. Reference: C.I.S. T56
Observing, Predicting, Quantifying, Interpreting.	2. Repeat the above using milk instead of water. Reference: C.I.S. S111
b. In physical change, the amount of matter taking part remains unchanged.	Media: ⊟ *Elements, Compounds, and Mixtures,* A493-2 ⊟ *Hydrogen, Oxygen, and Water,* A493-5 ⊟ *How Does Water Get Into the Air?,* PK-3676

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Quantifying, Predicting, Formulating hypothesis, Interpreting data.	1. Pour exactly one cup of water into an ice tray. Put tray in the refrigerator freezer for several hours. Remove the tray. Allow ice to melt. Would you expect to get exactly the same amount of water when you pour it back into the cup? Check to determine the answer.
Quantifying, Making operational definitions, Interpreting data.	2. Repeat the above using milk instead of water.
Observing, Experimenting.	3. Do the investigation—"A Fast Way to Change Water From a Solid to a Gas." Reference: C.I.S. S113, T57
Predicting, Experimenting.	4. Draw from students' suggestions how to set up an experiment to change water from a liquid to a gas to a liquid (distillation). Reference: C.I.S. S114-115, T57
c. All matter remains particulate.	Media: ⋈ *The World of Molecules,* S.V.E. ⋈ *What Are Things Made Of?,* C.O.R. ⋈ *Heat and How We Use It,* E.B.F. ⋈ *Chemical Changes,* McGraw-Hill ⋈ *Solids, Liquids, and Gases,* McGraw-Hill ⋈ *Composition of Air*
Skills: Investigating, Communicating.	1. Using sense of smell, match liquids to bottles they came from — water, pop, vinegar, etc. References· C.I.S. T58 S.M.A. T79
Investigating, Communicating.	2. Finding out about substances. Use of one's senses to tell substances apart. References: C.I.S. T58 S.M.A. T81-82, S144-149
Observing, Critical thinking.	3. Investigation to show the evaporation of perfume Reference: C.I.S. T58, S118-119
Observing, Critical thinking.	4. Investigation — What happens to mothballs? Reference: S119-120, T59
d. The smallest part of a substance is a molecule.	Media: ⋈ *The Physical Characteristics of Air* ⋈ *Air Around Us,* E.B.F. ⋈ *Things Dissolve,* McGraw-Hill ⋈ *Simple Changes in Matter,* C.O.R.
Skills: Investigating, Communicating, Defining terms.	1. Find out about molecules. What is a molecule? What is a molecule made up of? Reference: C.I.S. S121, S128
Formulating models.	2. Make models and diagrams to illustrate simple molecules — water, oxygen, hydrogen, sugar. (Use gumdrops, etc.) Reference: C.I.S. S121, S128
Observing, Interpreting.	3. Examine differently shaped bottles containing solids, liquids, and gases. Differentiate between the three states. Reference: C.I.S. S122
Observing, Interpreting.	4. Do the demonstration with dry ice. References: C.I.S. T59 S.M.A. S172
Inferring, Predicting, Experimenting.	5. How does our sense of smell give evidence of molecules? Our sense of sight? Reference: S.T.W. S40, 41 Bk. 6 S42, 43 Bk. 6
e. Substances can dissolve in other substances.	
Skills: Experimenting, Observing, Investigating, Explanation.	1. Dissolve some sugar in water. Why is this possible? What happens? Reference: C.I.S. S123-124
Defining Terms, Explaining.	2. Find out about the terms "solution" and "dissolving". Reference: S.M.A. S150-151 S162

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Predicting, Investigating.	3. Have a series of questions in which students must predict the outcome: a) What will sugar do if put into a glass of lemonade? References: S.M.A. S162-164 C.I.S. T60 b) What happens when you make instant coffee or tea? c) Which dissolves more salt — one-half cup of cold water or one-half cup of hot water? References: C.I.S. S127 S.M.A. S166
Predicting, Experimenting.	4. Test what water does to the three white substances — sugar, starch, and baking soda. Reference: S.M.A. T83, S150
Predicting, Experimenting.	5. Can you make a solution of oil and water? Reference: S.M.A. S165
f. The state of matter can change, but the amount of matter remains unchanged.	
Skills: Observing, Hypothesizing, Investigating, Quantifying.	1. Do the investigation — "Taking Salt Out of a Solution". Reference: C.I.S. S126, T60
Observing, Investigating, Communicating.	2. In hot water make saturated solutions of sugar and salt. Pour each solution into a shallow pan. Lay strands of string across the surface to make crystals. Study these. Reference: C.I.S. T61
Investigating, Communicating.	3. Find out about chemists and chemistry. How is a chemist's work like that of a detective? References: C.I.S. S128 S.M.A. T82, S148 4. Can chemists always depend on their senses?
g The application of energy can change the molecular structure of a compound.	
Skills: Analyzing, Explaining.	1. Investigation: Breaking up sugar molecules. Reference: C.I.S. S129, T62-63
Observing, Classifying.	2. Find out about the differences between elements and compounds. Make a display of samples of each. Reference: C.I.S. S131, 132
Observing, Predicting, Analyzing.	3. Break up the molecules of cornstarch and note constituents. Repeat using baking soda. Are any of these substances used in the mixtures used previously? How can you tell? References: C.I.S. T63 S.M.A. T83, S152
h. Solids may be combined to form a mixture.	
Skills: Critical Thinking, Communicating.	1. Make a mixture of sugar and pennies. Pupils should separate the substances. Easily done — no change in the sugar or in the copper. Reference: C.I.S. S134, T64
Theorizing, Communicating, Observing.	2. Separate a mixture of iron filings and sugar. Ask students for suggestions. Reference: C.I.S. S135, T64
Observing, Predicting, Investigating.	3. Separate a sugar and sand mixture. Ask for ideas for separating these. Lead up to the use of a filter. References: C.I.S. T64-65, S137 S.M.A. S162, 164
i. A solid and a liquid may be combined to form a mixture.	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
	Media: [ ] *Milliken Transparency Book, #T109* Physical and Chemical Changes: [ ] *What is Matter?*, page 1 [ ] *Properties of Matter*, page 2 [ ] *Physical Properties of Matter*, page 3 [ ] *Chemical Properties of Matter*, page 4 [ ] *Atoms*, page 5 [ ] *Molecules*, page 6 [ ] *Elements*, page 7 [ ] *Compounds*, page 8 [ ] *Mixtures and Solutions*, page 9 [ ] *Chemical Reactions*, page 12 [ ] *Types of Physical Changes*, page 16
Skills: Observing, Investigation.	1. Encourage students to make mixtures of a solid and a liquid: e.g., coffee grounds and water, instant coffee and water, dry milk and water, cocoa and milk, etc. Reference: C.I.S. T65
Predicting, Hypothesizing.	2. Students suggest ways in which the mixtures could be separated and test these. Reference: C.I.S. T65
Formulating models.	3. Students make their own filters to use. Reference: C.I.S. T65, S138
j. Substances in a mixture may be separated.	
Skills: Classifying, Inferring.	1. Review the ways in which mixtures may be separated. Reference: C.I.S. S137
Hypothesizing, Investigating, Communicating.	2. Separate a mixture of chalk and salt.
Hypothesizing.	3. Why can you get the same substances back when you separate a mixture? Reference: C.I.S. S139
k. A chemical change occurs when the molecules of a substance are broken down into their components.	
Skills: Observing, Inferring, Interpreting data.	1. Show some string to the class. How can scissors be used to change the string? Cut string into small bits. Analyze what has happened.
Observing, Inferring, Interpreting data.	2. Repeat the above using paper Have the molecules changed? Reference: C.I.S. T65
Inferring, Predicting.	3. What do we have to do to make the molecules change? Reference: C.I.S. T65
Observing, Inferring, Hypothesizing.	4. Burn the string and the paper. What has happened to the molecules? Reference: C.I.S. S141-142
l. A change is physical when the molecules of a substance remains unchanged in chemical structure.	
Skills: Investigating, Classifying, Communicating.	1. Find out about physical and chemical changes. What is the difference? Reference: C.I.S. T66
Classifying, Interpreting.	2. Students give their own examples to test understanding. Reference: C.I.S. S143, T66
Inferring, Predicting, Interpreting.	3. Investigate ways of bringing about physical and chemical change.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Predicting, Interpreting.	4. Leave a boiled egg yolk on a silver spoon overnight. What happens? Reference: C.I.S. T66
Interpreting data, Formulating models.	5. Use charts, exhibits, and demonstrations to show changes in sugar or other substances. Reference: C.I.S. T67, S144
m. Matter exists in various forms and states.	
Skills: Investigating, Critical thinking Classifying.	1. Present to the class, a jar of water, chunk of rock and an empty bottle. In what form is each substance? Reference: C.I.S. T67, S145
Critical thinking.	2. What do these substances have to do with our lives?
Defining terms.	3. Review compounds and elements.
Investigating, Communicating.	4. Find out about the water cycle and its importance. Demonstrate changes in the state of water (evaporation, condensation, solidification). References: C.I.S. T67 S.M.A. S174-175
n. Matter can change in form or state.	
Skills: Inferring, Predicting, Communicating.	1. By discussion bring out ideas about the earth's solid part — mainly rock. Does the rock part ever change? References: C.I.S. T68 S.T.W. S67-69, T16
Inferring, Predicting, Communicating.	2. Consider the earth's air blanket. What is it made up of? Is air matter? Explain. Reference: C.I.S. T68
Investigating, Reporting.	3. Find out about space exploits related to solid, liquid, and gaseous substances beyond the earth. Reference: C.I.S. T68
Formulating models, Communicating.	4. Arrange exhibits and give talks to other classes, parents, etc. Reference: C.I.S. T69-70

GRADE III

CONCEPTUAL SCHEME C

Living things are interdependent with one another and with their environment.

SUGGESTED MATERIALS AND EQUIPMENT

cans (food containers), cartons, wrappers from foods, 5 or 6 cups clean sand, 5 or 6 lumps of wet clay, 5 or 6 cups gravel or pebbles, white paper, 15 cups good topsoil, 30 magnifying lenses, 3 cups garden soil, 2 clear glass jars, pyrex pan with lid, milk cartons for filters, paper towels, electric hot plate, large glass pie pans, 12 small flower pots (filled with good topsoil), 4 packages radish seed, 6 sponges, 6 pans of water, 6 empty coffee cans, 6 glass containers to go under them, hammer, large nail, 6 measuring cups, 6 cups of each of these: sand, topsoil, rich humus, cactus or desert plants, hot water, Easter egg dye (tablets — 6 red — 6 blue), bunch of radishes, stalk of celery (with a few pale leaves), red ink, blue ink, 6 geraniums — daisies or carnations, 30 small pots, 30 one-half pint cartons, 30 cups clean sand, 30 cups good topsoil, 8 packages flower seeds: zinnia — marigold — nasturtium, etc., 1 large bottle of commercial plant food, 1 globe, ivy plants, beets, carrots, parsnips, turnips, sweet potatoes.

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S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⋈ Films
⋈8 Film Loops
⊟ Filmstrips
⊙ Records
●—● Tapes
[ ] Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **There are characteristic environments, each with their characteristic life.**	Introduce the scheme by discussing the meaning of treasures. What are some treasures that come out of the earth? What are the earth's greatest treasures? Reference: C.I.S. T74, S153
a. Plants and animals depend on matter in the environment for growth.	Media: *How Soil is Formed,* McGraw-Hill *Soil is for Growing,* McGraw-Hill *How a Plant Grows,* McGraw-Hill *How a Plant Makes Food,* McGraw-Hill *Plant Life of the Desert,* E.B.F.
Skills: Communicating, Inferring.	1. How were foods secured by the early pioneers and native Indians? Reference: C.I.S. T74
Interpreting, Inferring, Communicating.	2. Compare these methods with our own supermarket ways of obtaining foods. Reference: C.I.S. T74
Observing, Classifying, Communicating.	3. Collect and examine food cartons, tins, and wrappers. Where do these foods come from before they reach the supermarket? Reference: C.I.S. T74
Inferring, Predicting, Communicating.	4. Read the accounts of visits to a cattle ranch, a wheat farm, a chicken farm, and a dairy farm. Discuss the foods supplied by each Reference: C.I.S. S154-158
b. Some plants live together, two-in-one, and help each other.	
c. Man depends upon plants and animals for food.	Media: *What is Soil?,* E.B.F. *Your Friend the Soil,* E.B.F. *Bread,* E.B.F. *Autumn on the Farm,* E.B.F. *Spring on the Farm,* E.B.F. *Summer on the Farm,* E.B.F. *What Plants Need for Growth,* E.B.F *Let's Watch Plants Grow,* C.O.R.
Skills: Observing, Classifying, Investigating, Communicating.	1. Make a class exhibit of empty, clean, food containers. Group these by some plan. Students trace each kind of food back to its dependence on animals and plants which in turn depend on soil and water. Reference: C.I.S. T75
Observing, Classifying, Communicating.	2. Urban students should plan field trips or visits to surrounding farms — dairy, pig, poultry, vegetable, etc., and report on foods raised. Reference: C.I.S. T75
Observing, Communicating.	3. Rural students can report upon the kind of farming done on their farms — goods produced, etc. Reference: C.I.S. T75
d. Soil is composed of inorganic and organic materials.	
Skills: Observing, Classifying, Communicating.	1. Let each child examine some sand with a magnifying lens to determine: What is sand? Reference: T75
Observing, Classifying, Predicting.	2. Then allow each child to study some gravel and some clay. Are these broken up rock materials? Are they the same as soil or is soil different? Reference: T75
Observing, Classifying, Interpreting data, Defining terms.	3. Let each student examine 1 cupful of soil spread out on a paper. Put each kind of material into a separate pile. At the end combine the materials on two separate sheets. One containing materials **from Rocks;** the other materials **from Living Things.** Introduce the word **humus.** Reference: C.I.S. T76, S159-160

Concepts and Subconcepts	Suggested Activities and Instructional Materials
e. Matter, in soil, is composed of three states. Soil contains materials for plant growth.	
Skills: Inferring, Hypothesizing, Experimenting, Interpreting data.	1. Is there water in soil? Ask students how they could prove this. Then investigate by heating a cup of garden soil in a pyrex pot covered by a lid. What happens? Explain. Reference: C.I.S. T67, S161
Predicting, Hypothesizing, Interpreting data.	2. Is there air in soil? Put some garden soil in a jar and some water in a second jar. Slowly add water to the jar containing the soil until the jar is full. Stir the mixture and let stand. What do you notice? Explain what happens. Reference: C.I.S. T76, S162
Predicting, Investigating, Interpreting data.	3. Is there anything in soil that dissolves in water? How can we find out? Mix some soil and water. Pour it through a filter. Catch the liquid and pour it into a glass pie plate until the water evaporates. Ask class to predict what will happen. What is on the pie plate? Reference: C.I.S. T77, S163
f. Various soils have differing capacities for the retention of water.	Media: *Milliken, T201:* [ ] *Kinds of Plants, #1* [ ] *What Plants Need to Grow, #6* [ ] *Parts of Plants, #2* [ ] *What We Get From Plants, #7* [ ] *Plant Growth and Change, #8* [ ] *Trees, #9*
Skills: Observing, Inferring, Interpreting data.	1. What is a sponge? Allow students to find out how water is held in a sponge. Try different kinds of sponges. In what way is soil like a sponge? Reference: C.I.S. T77, S165
Hypothesizing, Experimenting, Interpreting data, Controlling variables.	2. What kind of soils hold water best? Prepare three coffee cans by making six equal-sized holes in the bottom of each. In the first can place one cup of sand, in the second one cupful of garden soil, and in the third one cup of humus. Label the cans and place each one over a glass jar. Add exactly one cup of water to each can of soil. From which can does the water drip first? From which can did the water stop dripping first? Which held water for the shortest time? The longest time? Which is the best soil for holding water? The poorest? (Allow for different kinds of garden soils.) Reference: C.I.S. T78, S166-167 Media: *Milliken, T107:* [ ] *Plants, #3* [ ] *Bacteria, Algae, and Fungi, #4* [ ] *Photosynthesis, #5* [ ] *Ferns and Mosses, #6* [ ] *Flowering Plants, #7* [ ] *Plant Parts and Functions: Roots and Stems, #8* [ ] *Leaves and Flowers #9*
g. All plants require water for life.	Soil in the Woods and on the Deserts:
Skills: Inferring, Interpreting.	1. Students discuss experience (first hand or via books, films or television) to review the concept of each type of environment: kind of soil, amount of plant growth, kinds of plants, special adaptations. Reference: C.I.S. T78, S168-170
Inferring, Interpreting data.	2. Cut open the thick, pulpy stem or leaf of a cactus plant. Why do you think this pulpy inside helps the plant? (Stores water?) References: S.M.A. T23, S30 S.T.W. Bk. 6 S246, 247, S252
Inferring, Predicting, Interpreting.	3. Notice the different kinds of house plants at home. Report on those which need most water. Explain why plants need water.
h. There is a flow of materials between living things and their environment.	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Observing, Experimenting, Interpreting data.	1. Mix crushed Easter egg dye tablets with sand. Place the mixture in a filter can. Pour hot water over the mixture. Notice the color of the liquid that comes through the filter. What happened? Molecules of dye mixed with molecules of water to form a solution. In a similar way soil water dissolves minerals. Reference: C.I.S. T79
Observing, Defining terms, Predicting.	2. How do mineral solutions get into the plants? Give each child a radish seedling, a mature radish, and a magnifying glass. Identify roots, rootlets and root hairs. What do they do for the plant? References: C.I.S. T79, S171-172 S.M.A. T21, S24
Observing, Classifying (comparing).	3. Study the roots of grass, weeds, carrots, beets, etc. Compare these with radishes. References: C.I.S. T79-80, S175 S.M.A. T20, S16 4. Make root gardens by placing a beet, carrot, turnip, and parsnip in a glass dish filled with gravel. Add water so that the ends of the roots are covered. Reference: S.M.A. T20-21, S17, 18, 19, 20 5. Do plants need roots? Do the activities in S.M.A. Reference: S.M.A. S21, 22, 23, 24
Observing, Hypothesizing, Interpreting data.	6. Place a stalk of celery in a solution of dye and water. What happens? Explain why. (Set in the sun to speed up activity). References: C.I.S. T80, S173 S.M.A. S25, T22
i. Minerals travel from regions of greater concentration to regions of lowest concentration.	
Skills: Predicting, Experimenting, Hypothesizing.	1. Label three pots of previously prepared radish plants. #1 is to receive no water, #2 is to be kept damp, and #3 is to be kept filled with water at all times. Ask children to predict how the investigation will turn out? Why? References: C.I.S. T80, S174 S.M.A. T21 2. Find out what happened in C.I.S. book.
Deferring judgment, Explaining variables.	3. Account for any discrepancies in the class experiment.
Experimenting, Formulating models.	4. Let pupils experiment making flowers of different colors (a blue geranium from a white one; a green carnation, a red daisy, etc.) by inserting stems in different solutions. References: C.I.S. T80 S.M.A. S26
j. Living things need a suitable environment for growth.	
Skills: Hypothesizing, Planning an experiment, Deferring judgment, Concluding.	1. Let children pair off. Each pair needs two containers—one for white sand, one for garden soil. Plant 4 seeds of the same kind in each container. Keep planters together in pairs. Some pairs may be placed on the floor, some on a window sill, some in a shady corner, some outdoors, etc. Once planters are in place, allow students to speculate. Are we sure how the investigation will turn out? Explain that sand is not always poor in substances that plants need. Reference: C.I.S. T81, S176
Inferring, Predicting.	2. Can plants grow in the same soil year after year? Do soils become poor? Reference: C.I.S. T82
Investigating.	3. Find out how poor soils can be made better. (Legumes, summer fallow, crop rotation, fertilizers). Reference: C.I.S. S177-179
Investigating, Observing.	4. Use fertilizer on one of the two of the above pots which contain poor plants. Reference: S.T.W. S213-215

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Investigating, Interpreting data.	5. Study a globe. Find out where most of the world's people live. (On a layer of soil in which plants can grow). Reference: C.I.S. T82-83
Conceptualizing.	6. Refer back to the introduction. What is the earth's greatest treasure? Why? Reference: C.I.S. S180-181 7. What would it be like without soil? Reference: S.M.A. T55 8. Do plants grow better in some soils than others? Do investigation in S.M.A. Reference: S.M.A. S98-99

GRADE III

CONCEPTUAL SCHEME D

A living thing is the product of its heredity and its environment.

SUGGESTED MATERIALS AND EQUIPMENT

Geranium plants, bean seeds — lima, pebbles — the size of lima beans, cooking pan, water, electric burner, blotters, goldfish, tropical fish, guppies, tadpoles, frogs, salamanders, turtles, snakes, budgie bird, gerbils, guinea pig, rabbit, hamster, mealworms, caterpillars, magnifying lenses, feathers, fur, leather, bones, shells, ivory, snakeskin, cast-off insect skins, horns, seeds, leaves, vertebrae, lobster, spiders, butterflies, beetles, plastic pieces, glass, metal pieces, pieces of wood, fresh flowers, plastic flowers, fresh green leaves, rubbing alcohol, measuring cup, wooden sticks, newspapers, bricks, rocks, fresh mushrooms, glass jars, fresh bread, dry toast, cakes of yeast, sugar, warm water, apples, oranges, green peas, pine cones, fir cones, spruce cones, fern fronds, moist terrarium, leaves, microscopes, glass slides, onion, specimen from seed plants, specimen from spore plants, red ink, food coloring, heavy duty wax paper, electric iron, minerals, rocks, topsoil, sheets of plastic, elastic bands, lichens, wheat seeds, radish seeds, tulip bulbs, plant containers, gravel, paper bags, bleach, coat hangers, paper clips, black paper, vaseline, glycerine.

SUPPLEMENTARY REFERENCES

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Code for Media:

⧓	Films	⊙	Records
⧓8	Film Loops	●_●	Tapes
⌸	Filmstrips	[ ]	Slides or Transparencies

Code for References:

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S.M.A. — *Science, A Modern Approach*, Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Living things are related through possession of common structure.**	
a. Living things have life activities: they move, grow, respond, and reproduce. Skills: Observing, Classifying, Communicating.	1. Present a group of objects such as: toy car, salt and pepper shakers, a plant, a turtle, an animal bone, a plane, a goldfish, a piece of chalk, a rock, a bean seed, a balloon. Ask students about the two groups in which the objects may be classified. Help them discover the groups used by scientists — living and non-living. Reference: C.I.S. T90-91 S184-187

Media:
- *Animals, Plants, and Their Environment*, McGraw-Hill
- *How Animals Are Grouped*, McGraw-Hill, PK-2877
- *Fungi, Our Non-Green Plants*, McGraw-Hill
- *How a Plant Grows*, McGraw-Hill
- *How a Plant Makes Food*, McGraw-Hill
- *Living Things*, S.V.E.
- *Reptiles*, S.V.E.
- *Finding Out About Mammals*, S.V.E.

Observing, Classifying, Communicating.

2. How can you tell the living things from the non-living? By discussion, allow pupils to discover characteristics that distinguish the two groups. Use questions like the following:
   — Which things move by themselves?
   — Which things move only when something from the outside makes them move?
   — Does a plant move? Study the effects of temperature, light etc.
   — Which things can grow?
   — How did the plant and the fish get started? — from a single egg.
   — What do living things need to keep alive?

Reference: S.T.W. T106-108

Media:
- *Dependent Plants*, S.V.E.
- *Mushrooms*, S.V.E., PK-3699
- *Mr. and Mrs. Mallard and Their Family*, S.V.E.
- *Backyard Insects*, S.V.E.
- *Learning About Mammals*, E.B.F.
- *Learning About Birds*, E.B.F.
- *Learning About Amphibians*, E.B.F.

Observing, Classifying, Communicating.

3. Have a field trip where children collect materials from living and non-living things.

4. How can you tell the difference between a plant and an animal? By discussion and reading bring out the idea that this puzzled scientists for a long time.

Reference: S.T.W. T102-104

Classifying.

5. Make charts using pictures to show living and non-living things.

Media:
- *Learning About Reptiles*, E.B.F.
- *Learning About Insects*, E.B.F.
- *Work of Flowers*, E.B.F.
- *Seeds and How They Travel*, E.B.F.
- *Plant Needs*, E.B.F.
- *How Plants Live*, E.B.F.
- *The Parts of a Plant*. E.B.F.
- *How Seeds Sprout and Grow Into Plants*, E.B.F.
- *How Seeds Are Scattered*, E.B.F.
- *Plant Life of the Desert*, E.B.F. PK-2129
- *Mammals of the Desert*, E.B.F. PK-2126
- *Reptiles of the Desert*, E.B.F. PK-2127

a. All plants and animals are made up of one or more cells.

Skills: Observing, Communicating.

1. To help students grasp the idea of the smallness of cells have them observe sugar cubes with magnifying glasses. What is the sugar cube made of? Most cells are much smaller than grains of sugar. How might we see them?

2. Observe cell walls by examining dead, dry leaves.

Reference: S.T.W. T104-105

Observing, Communicating.

3. Observe plant cells by stripping off the outer layer of a geranium leaf or an onion and putting it on a microscope slide.

4. Observe animal cells by gently scraping the inside of your cheek and smearing the scrapings on a slide.

Observing, Communicating.

5. Examine illustrations of typical animal and plant cells to determine the differences.

	Media: *How Animals Live in the Air,* Curr. *How Animals Live in the Sea,* Curr. PK-2172 *How Animals Live in the Grasslands,* Curr. PK-2170 *How Animals Live in the Swamps,* Curr. *How Animals Live in the Arctic,* Curr. PK-2169
c Living things are interdependent with their environment.	1. Investigation—"Where Beans Must Live". Reference: C.I.S. T92-93
Skills: Hypothesizing, Predicting, Controlling variables.	
Inferring, Predicting.	2. Discussion: In what kind of place do we find fish, beaver, penguins, camels, cactus, polar bears, etc.? Reference: C.I.S. S188-193
Inferring, Predicting.	3. Why don't we see bees in the winter?
	4. List trees and animals native to student's area.
d. Living things are adapted to special environments — desert, forest, mountains, sea, ground.	1. Establish an understanding of the terms **adapted** and **environment.** Reference: S.T.W. T109
	2. Students work in groups to report on how certain animals and plants are adapted to live in: — deserts — seas — forests — ground — mountains
Skills: Observing, Classifying, Inferring, Interpreting data.	References: C.I.S. T93, S190-193, S270-277 S.T.W. T109-127
Communicating, Observing, Predicting.	3. Visit a zoo or a game farm. How can non-native animals be kept in zoos or on game farms? Reference: S.T.W. T128-150
	Media: *The Cell-Structural Unit of Life,* Cor. T-678 *Animals With Backbones,* Cor. T-1414 *Living and Non-Living Things,* Cor. *Putting Animals in Groups,* I.F.B TK-1363 *What's Alive?,* F.A. *Fish Are Intresting,* F.A. *Reptiles Are Interesting,* F.A. *Birds Are Interesting,* E.B.F. TK-1275 *Mammals Are Interesting,* E.B.F. TK-953
e. Vertebrates have characteristics in common. Skills: Observing, Classifying, Communicating, Interpreting data.	1. Observe classroom pets such as goldfish, tadpoles, frogs, turtles, budgie bird, guinea pig, rabbit, snails, and mealworms. Discuss difference in appearance, locomotion, skin covering, types of homes, food, ways of obtaining food, etc. Reference: C.I.S. T94, T194-201
	2. Students group the animals shown on pages 194-195 of C.I.S. (Pictures brought by students could also be used).
Observing, Classifying, Communicating, Interpreting data.	3. Names should be grouped on the board. By reading and discussing, name the class to which each group belongs. Develop an understanding of the characteristics of each group — fish, amphibians, reptiles, birds, mammals.
	4. Make an animal scrapbook or animal charts for each of the five classes studied. Save pictures of animals that do not belong in these groups until later.
	Media: *Amphibians, Frogs, Toads, and Salamanders,* F.A. TK-1476 *Living Things are Everywhere,* E.B.F. TK-1872 *Learning About Flowers,* E.B.F. T-1285 *Learning About Leaves,* E.B.F. *Learning About Seeds,* E.B.F. TK-2221 *Care of Pets,* E.B.F. *Life on a Dead Tree,* F.A.

f. All animals may be divided into two groups: vertebrates and invertebrates.

Skills: Observing, Classifying, Interpreting data, Communicating.

1. Collect all kinds of materials that were once part of animals. From what animal did each come? To which of the five previous groups does the animal belong? Which materials come from animals that do not belong to any of the five classes?

Reference: C.I.S. T96

Media: ▶◁$_8$ *From Caterpillar to Moth,* I.C.F.
▶◁$_8$ *Little Animals — Land and Water,* I.C.F.
▶◁$_8$ *Tidepool — Life I,* I.C.F.
▶◁$_8$ *Tidepool — Life II,* I.C.F.

2. Prepare a collection of bones, vertebrae or complete skeletons of chicken, fish, frogs, turtles, snakes, cats.

3. Investigation—"What a Backbone is Like".

References: C.I.S. T97, S203-204

Inferring, Formulating models.

4. Make a model of a backbone from spools and string.

Reference: C.I.S. S205

5. Invite a nurse to shown X-ray views of the human backbone (spine).

g. Classification of living things is based on characteristics held in common within the group.

Skills: Observing, Classifying, Inferring, Communicating.

1. To help children understand classifying, ask how the students in the class might be grouped: age, sex, color of hair, eyes, skin, etc.

Reference: C.I.S. T98-99

2. Review classification of energy, forms of things.

Reference: C.I.S. S206-211

3. Complete the classification of animal materials which did not belong to the five groups of invertebrates.

4. By using the Roll Call of Animals in C.I.S. classify spiders, starfish, coral.

Reference: C.I.S. S288-308

5. Add a section on Invertebrates to your animal scrapbook or charts.

Media: Milliken Transparency Books:
[ ] *Plants and Animals:* pages 1, 3, 8, 10, 18, 20
[ ] *Our Living World:* pages 1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

h. Green plants have characteristics in common.

1. Discuss: What kind of plants are there? What do they have in common? Are there some kinds which seem quite different from others? Do all plants have flowers, etc.?

Reference: C.I.S. T106

Skills: Observing, Classifying, Communicating.

2. Read about the pitcher plant. Why would you classify it as a green plant and not an animal?

Reference: C.I.S. T107, S213-214

Observing, Quantifying, Predicting, Hypothesizing.

3. Investigation: What makes a plant green?
*CAUTION: DO NOT TRY TO HEAT THE ALCOHOL.

Reference: C.I.S. T107, S215

Inferring, Interpreting data.

4. Why are the leaves of grass plants that grow under a rock white in color?

Reference: C.I.S. S216-217

5. Collect stems, twigs, leaves, roots, and flowers, to mount on paper showing "Parts of Green Plants".

6. Raise some insect-eating plants.

Reference: C.I.S. T108

i. Non-green plants have characteristics in common.

1. Give students magnifying lenses and mushrooms. Stimulate observations. What shape are they? Do they smell like green plants? Are there any green parts? Where have you seen them growing?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Observing, Classifying, Communicating.	Reference: C.I.S. T108, S218
Hypothesizing, Investigating, Predicting.	2. Investigation: "How Plants Grow Without Chlorophyll." What did the mould plants need? Reference: C.I.S. T109, S219-224 3. Grow some yeast plants. Reference: C.I.S. T110
Observing, Classifying, Communicating.	4. Make a chart showing pictures of non-green plants. On it list the characteristics possessed by non-green plants. Reference: C.I.S. S225 Media: (See Audio Visual Services Branch. See also productions of the "Question Mark Trail" series—School Broadcasts, Audio Visual Services Branch.) ●_● *Turtles* ●_● *The Toad* ●_● *The Rattlesnake* ●_● *Minnows and Snails* ●_● *Wonders of a Pond in Spring* ●_● *Spring Secrets* ●_● *The Quiet Sleepers* ●_● *The Bat*
j Certain groups of green plants reproduce by seeds.	1. Children examine peapods, pine cones, and fern fronds. On what kinds of plants did these grow? What would happen if flowering plants had no fruits, pine trees had no cones and fern fronds no spore cases?
Skills: Observing, Discussing, Classifying, Predicting.	Reference: C.I.S. T111, S228-229 2. Investigation: What is Inside a Flower? References: C.I.S. T111, S230 S.M.A. T47-50
Formulating models.	3. Make a big drawing of a flower showing stamens, pistil, and ovules. 4. Read to find how flowers are pollinated. References: C.I.S. S231
k. Certain groups of green plants reproduce by means of spores.	1. Students use magnifying glasses to observe fern leaves. What do you see on the back of a fern leaf? Press the back of the fern leaf on paper. Look for specks on the paper. What are these?
Skills: Observing, Predicting.	Reference: S.M.A. T53 2. Collect some mosses. Hunt for caps at the tops. Press one on paper. What do you find? Reference: S.M.A. T53
Formulating models	3. Make a moss and fern garden. Reference: S.M.A. T54
l. Plants may be classified in two main groups: those with and those without liquid-conducting tissue.	
Skills: Observing, Inferring, Predicting.	1. Investigation: "How Water Can Move Up?" Reference: C.I.S. T113-114, S236-239
Inferring, Classifying, Communicating.	2. Read and discuss: plants with tubes. 3. Read and discuss: plants without tubes.

GRADE III

CONCEPTUAL SCHEME E

Living things are in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

Equipment: aquarium, fish, snails, green water plants, collecting jars, glass tank, straight-sided jars, various fossils, field glasses, magnifying glasses.
Classroom plants: cacti, geraniums, ferns.
Classroom animals: gerbils, guinea pigs, turtles.
Preserved specimen of: sand dollars, sea anemone, sea cucumber, starfish, snakes.
Live specimen: earthworms, mealworms, ants, tadpoles, mosquito wrigglers, dragonfly nymphs, algae.
Large pictures of: gophers, bears, dinosaurs, seals, whales, zebras, kangaroos.
Small models of: dinosaurs, stuffed birds and animals.
Equipment: plaster of paris, modelling clay, paper for murals, microscopes, micro-projectors or bioscopes, petroleum jelly (vaseline).

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Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Living things grow and develop in different environments.**	Introduction: Arouse interest by questions such as: Have living things always been the same? How do you know? How do scientists know? Where did the first life start? Which appeared first: plants or animals? Why did life develop in that order? Allow students to express their ideas without telling them whether they are right. Ask them how they might check their ideas. Allow time for library research and further discussion. Reference: S.T.W. T74-76
a. Simple plants such as algae, were among the first things to develop on the earth.	Media: ⊟ *The Vanishing Prairie*, Walt Disney, E.B.F. ⊟ *The Living Desert*, Walt Disney, E.B.F. ⊟ *Mammals of the Tropical Forests*, Walt Disney, E.B.F. ⊟ *Marine Mammals of the Northland*, Walt Disney, E.B.F.
Skills: Observing, Classifying, Communicating.	1. Collect algae from a pond or brook and examine it under a microscope. Have they stems, leaves, or roots? What color are they? Why? Reference: S.T.W. T93
Observing, Classifying, Communicating.	2. Collect a container of pond water containing a small amount of green algae. Put it in sunlight for about a week. What happens to the water as the algae develops? Examine specimens under a microscope or a micro-projector. Reference: S.T.W T93
Observing, Inferring, Hypothesizing.	3. Examine plant and animal fossils. What do they tell us? How were they made?
Formulating models.	4. Make some fossils using plaster of paris. Media: ⊟ *Prehistoric Animals*, McGraw-Hill ⊟ *Backyard Insects*, S.V.E. ⊟ *Let's Explore a Pond*, S.V.E. ⊟ *Tropical Fishes*, S.V.E.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
b. Fresh water animals have special adaptations to their environment.	
Skills: Observing, Classifying, Communicating.	1. Organize a field trip to a pond or stream in the vicinity. Collect pond water containing live specimens to set up a pond-life aquarium in the classroom.
	References: C.I.S. T121-122 S.T.W. Bk.4 S162-163
Skills: Observing, Classifying, Communicating.	2. Isolate various specimens in separate jars for further observation and identification. How do they move? How do they get air? How do they get food?
Observing, Formulating models.	3. Trace the life cycle of the following animals by making charts: dragonflies, diving beetles, giant water bugs, mosquitoes, fish, snails, frogs.
	References: C.I.S. S246-250 S.M.A. Bk.4 S164-165
Observing, Communicating.	4. What adaptions have they for moving, getting air, and getting food in the pond?
Observing, Inferring Hypothesizing.	5. How are mosquitoes controlled in your area? Explain why this is done.
	Reference: C.I.S. S251
Observing, Classifying, Communicating.	6. Keep goldfish and turtles in the classroom and observe their adaptations.
	Media: ⧓ *Marine Life,* E.B.F. ⧓ *Life in Grasslands,* E.B.F. ⧓ *Fresh Water Pond,* E.B.F. TK-1564 ⧓ *Creatures of the Desert,* McGraw-Hill ⧓ *Adelie Penguins of the Antarctic,* McGraw-Hill ⧓ *Wonders in the Desert,* C.F. ⧓ *Wonders in Country Stream,* C.F. ⧓ *Wonders in Your Own Backyard,* C.F.
c. Marine animals have special adaptations to their environment.	
Skills: Observing, Communicating.	1. Students who have visited the ocean, an oceanarium or marineland might tell the class about the animals seen.
Inferring, Hypothesizing.	2. Could a starfish live in our aquarium?
	Reference: C.I.S. T122
	3. How do sea animals get food and air? How do they move?
	References: C.I.S. S252-253 S.M.A. Bk. 4 S165-167
Observing, Investigating, Hypothesizing.	4. How are penguins, whales, and seals adapted for living in the icy seas?
	Reference: C.I.S. T123, S254-256
Observing, Researching.	5. How are coral, sea anemone, sea cucumbers, etc., adapted for living in the warm seas?
	Reference: C.I.S. T124
Formulating models.	6. Students make murals of marine life.
	Reference: C.I.S. S257-260
d. Animals of the past adapted to environment; certain animal species became extinct when the environment changed.	
Skills: Observing, Formulating models.	1. Students make charts or drawings for a roller movie showing "The Story of Living Things".
	Reference: S.T.W. T74-86
Inferring, Communicating.	2. Where did the first animals develop? Why?
	References: C.I.S. S262-265 S.T.W. T74-75
Inferring, Applying.	3. What did the animals need before they could invade land?
	References: C.I.S. S266 S.T.W. T76-77
Observing, Analyzing, Inferring.	4. Why do you think these animals became extinct: trilobites, dinosaurs, dodo bird, saber-toothed tiger, mammoths, passenger pigeon?
	References: C.I.S. S264-265 S.M.A. S109, 197, 201 S.T.W. T78-79

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Communicating.	5. How does man differ from other living things? Reference: S.T.W. T82-84, 88
Observing, Reporting.	6. Visit the Calgary Zoo or the Drumheller Park to see the models of dinosaurs.
Observing, Analyzing, Making models.	7. Students can make dioramas of prehistoric life using small boxes. Reference: S.M.A. Bk. 4 T79-80
e. Organisms have become adapted to many different environments.	
Skills: Observing, Analyzing, Predicting.	1. Introduce this section by asking why these animals could not live in the sea: butterfly, rabbit, sparrow, ant. Bring out the idea that these are adapted to life in a land environment. Reference: C.I.S. T127
Observing, Reporting.	2. Read about our grasslands. What plants and animals are adapted to living here? Reference: C.I.S. S266-269
Inferring, Hypothesizing, Communicating.	3. Why do very few buffalo remain today?
Observing, Analyzing.	4. How do African grasslands differ from ours? Reference: C.I.S. T128, S270
Researching, Communicating.	5. Name plants and animals found in the forest areas and tell how they are adapted to life there. References: C.I.S. T128, S270-274 S.M.A. BR-4, S154-155 S.T.W. T110, 117, 119
Researching, Observing, Communicating.	6. Name plants and animals found in a desert. Show how they are adapted to live there. References: C.I.S. T129, S275-277 S.M.A. Bk. 4 S158-159, T67-68 S.T.W. T109, 114, 116
Analyzing, Formulating models.	7. Make a desert terrarium.
Observing, Classifying, Communicating.	8 Go on a field trip close to your school. List the plants, bugs, insects, and other animals you see. How do they move, get food, and breathe? References: C.I.S. T130, S278 S.M.A. Bk. 4 T151, 152
Observing, Formulating models.	9. Start an ant colony and study the behaviour of ants. Reference: S.M.A. Bk. 4 T161
Observing, Formulating models.	10. Make a "wormarium" for earthworms. Reference: S.M.A. Bk. 4 T68
Skills: Observing, Formulating models, Communicating.	11. Raise mealworms for study. Media: Our *Living World*, Gr. 5-9, Milliken, 1966: [ ] *Bacteria, Algae,* Fungi, p. 4.. [ ] *Ferns and Mosses*, p. 6 [ ] *One Celled Animals*, p. 12 [ ] *Simple Animals*, p. 13 [ ] *Echinoderms*, p. 14 [ ] *Mollusks*, p. 15 [ ] *Insects*, p. 17 [ ] *Fish & Amphibians*, p. 18 [ ] *Reptiles & Birds*, p. 19 [ ] *Mammals*, p. 20 *Plants and Animals*, Primary, Milliken, 1967: [ ] *Animals That Live in Water*, p. 11 [ ] *Animals on Land*, p. 12 [ ] *How Animals Move*, p. 13 Non Projective Materials: [ ] *Plant and Animal Pictures*, S.V.E.

GRADE III

CONCEPTUAL SCHEME F

The Universe is in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

electric lamp, high wattage bulb, scissors, ball of string, sponge balls, tagboard sheets (24" x 36"), orange, grapefruit, yardstick, 3" x 5" cards, scotch tape, classroom planetarium, binoculars, monoculars, opera glasses, student telescopes, magnifying lenses, large thin convex lens, small thick convex lens, black construction paper, black cloth, yellow chalk, round balloons, beach ball, styrofoam balls of different sizes, paste or glue, wire, roll of wrapping paper, cardboard tubes (different sizes), "Universal Map of Outer Space" — Rand McNally, globe, projector, local newspaper, basketball, ping pong balls, modeling clay, plasticine, large piece of stiff bristol board, plibond glue, package of shot (BB's), long slender stick, corks, freely-turning wheel.

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Code for Media:

⋈	Films	⊙	Records
⋈8	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Code for References:

C.I.S. — *Concepts in Science*, Longmans.

S.M.A. — *Science, A Modern Approach*, Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1 **There are seasonal and annual changes within the solar system.**	
a. The Earth and eight other planets move in orbits around the sun.	
Skills: Observing, Communicating.	1. Introduce the scheme by reference to some recent trips into space. e.g., Apollo XI orbits the moon. Ask students what else travels in space. Discuss.
Observing, Classifying, Quantifying.	2. Students study the wall chart "Universal Map of Outer Space" to review ideas introduced in Grade II, and to interpret scale and pictorial drawings. How many planets are there? Which are larger than the earth? Which are smaller? Which are between the Earth and the Sun? Which are farther away? References: C.I.S. Bk. 2 T126-131 S.M.A. Bk. 4 254 S.T.W. 32-35
Observing, Interpreting data, Formulating models.	3. Students demonstrate how the earth rotates as it revolves around the sun.
Interpreting data, Communicating, Experimenting.	4. Students find out what keeps the planets on their orbits and demonstrate to show the tug-of-war between gravity and inertia. References: S.M.A. Bk. 4 T244-245
Classifying, Inferring, Predicting.	5. Students speculate about the meaning of the title "Too Much, Too Little, or Just Right". Reference: C.I.S. T40, S74-75

Concepts and Subconcepts	Suggested Activities and Instructional Materials
	Media: ⊟ *The Earth and Its Neighbors in Space*, E.B.F. ⊟ *Flight Around the Moon*, E.B.F. ⊟ *Flight Into Space*, E.B.F. ⊟ *Man and the Moon*, E.B.F. ⊟ *What is in the Sky?*, Curr. PK-2191 ⊟ *The Sun's Family*, J.H. ⊟ *Interesting Things About the Planets*, J.H., P-254 ⊟ *Our Neighbor the Moon*, J.H. P-255 ⊟ *The Changing Moon*, J.H. P-256 ⊟ *Our Solar Family*, F.O.M. ⊟ *The Earth as a Planet*, N.F.B. P-2558 ⊟ *Destination Moon*, Y.L.P. PK-3239 ⊟ *Leaving the World*, S.V.E. ⊟ *Current Events in Space*, S.V.E. ⊟ *Man in Space*, S.V.E. ⊟ *Space Travel A.D. 2000*, S.V.E. PK-3809
b. The Sun is our nearest star, and is the chief source of energy for the planets of the solar system.	
Skills: Communicating.	1. Review or recall ideas about the Sun's energy from Scheme A. Reference: C.I.S. Bk. 2, T-65-66
Observing, Quantifying, Communicating.	2. Review and discuss answers to the following questions: • What is the Sun? • Why does it look so much larger and brighter than other stars? • What do we get from the Sun? • How does the size of the Sun compare with the size of other stars? • How far is the Sun from the Earth? References: C.I.S. T78-79 S.T.W. T33, 39 S.M.A. Bk. 4 T255
Observing, Quantifying, Formulating models.	3. Make a model showing how the size of the earth compares with the size of the sun. Use a bead and a beach ball. Reference: C.I.S. Bk. 2
Quantifying, Communicating, Interpreting data.	4. By using a ball and an electric lamp in a darkened room, show how the amount of light going from the light to the ball is affected by the distance between them. Reference: S.T.W. T39
c. Heat travels through the atmosphere.	
Skills: Observing, Communicating, Hypothesizing.	1. Students take turns, each holding one hand in the path of light that streams from an electric lamp with a high wattage bulb. How far from the bulb can the heat be felt? Where is the heat the greatest? How does the heat travel to your hands? Reference: C.I.S. T40-41
Skills: Inferring, Predicting.	2. Ask students what they have learned from this experiment that might help them tell about the temperature of the planets. Media: ⋈ *Asteriods, Comets, and Meteorites*, F.A. ⋈ *Earth and the Sun*, Cenco ⋈ *The Moon*, Cenco T-209 ⋈ *Satellites — Stepping Stones to Space*, F.A. ⋈ *How We Know the Earth Moves*, F.A. ⋈ *The Solar Family*, E.B.F.
d. Each planet receives energy in proportion to its distance from the sun.	1. Students observe a model planetarium or a chart of the solar system to suggest and discuss reasonable answers to the following questions:
Skills: Observing, Communicating, Predicting.	• Which planet is the hottest? • Which planet is the coldest?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
	• Would you find plants and animals like ours living on Mercury? Why? • Could anything that needs water live on Pluto? • On which planet do we know conditions are suitable for plant and animal life? • On which planets would there be the greatest possibilities of plant and animal life?
Interpreting data, Comparing.	2. Students do research to check their answers and obtain more information about the planets. References: C.I.S. T76-96 S.M.A. Bk. 4 T259-263 Media: ⧓ *The Sun's Family*, M.G.H. T-932 ⧓ *A Trip to the Planets*, E.B.F. ⧓ *This is the Moon*, M.G.H. T-730 ⧓ *Exploring the Night Sky*, E.B.F. ⧓ *The Moon*, E.B.F. T-209 ⧓ *A Trip to the Moon*, E.B.F.
Interpreting data, Communicating.	3. Students make a chart of the planets showing distance from the sun, diameter, number of moons, length of year (revolution), length of day (rotation), atmosphere, etc. References: S.M.A. Bk. 4 T254 S.T.W. T35
Quantifying, Interpreting data, Formulating models.	4. Make a model of the solar system by using round balloons, paper and paste. Suspend these from a wire or string stretched across the room. Reference: C.I.S. T42-43
Skills: Observing, Comparing.	5. Check on the meaning of the title, "Too Much, Too Little, or Just Right", on p. 74 of C.I.S. Reference: C.I.S. T42
Observing, Interpreting data, Communicating.	6. Locate Venus and other planets in the night sky. Reference: C.I.S. T96 S.M.A. Bk. 4 T259
e. The heat energy on a planet depends on the light energy it receives from the sun. A planet receives more heat energy during a day than during a night; also more heat energy during summer than during winter.	
Skills: Observing, Quantifying, Experimenting.	1. Place an unshaded light on the floor. Using a light meter, take readings at different distances from the light. Place thermometers at the same distances from the light and take readings. What relationship is there between the light and the heat at different distances?
Observing, Communicating.	2. Review: What causes day and night? Where is the sun at night? Reference: C.I.S. Bk. 2 T128-129
Observing, Communicating, Interpreting data.	3. Demonstrate day and night by using a light and a ball or a globe. Make an "X" where you live. Discuss: When does a planet receive more heat from the sun? During the day or during the night? Why? Reference: S.T.W. T36-38
Observing, Communicating, Formulating models.	4. Cover a table with paper. Make an ellipse on the paper. Place an unshaded electric light at the center. Move a globe around the ellipse rotating it as you do so. Discuss the following questions: • In what direction is the North Pole tilted in the summer? • For how many hours will the North Pole be in the light of the sun in the summer? • What happens to the South Pole in the fall? • In winter, which part of the earth is receiving most of the sun's light? • When are both poles in light at the same time? Reference: S.M.A. Bk. 4 S252-253
f. Earth and Mars receive similar amounts of energy from the sun.	
Skills: Observing, Communicating, Interpreting data.	1. Students study charts and models of the solar system made earlier. Compare the amounts of energy the Earth and Mars receive from the Sun.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Comparing.	2. Check predictions by reading. References: C.I.S. S82-86 S.M.A. Bk. 4 S260-261
Quantifying, Formulating models.	3. Use an electric lamp for the Sun. Measure off strings 93 inches and 141 inches long to represent the distances from the Sun to the Earth and Mars. Fasten one end of each string to the lamp and on the other ends fasten cards with dots labelled Earth and Mars respectively. Two children at a time should move the "planets" left to right on their orbits. Do they stay together? Does one go faster than the other? Which planet should have a higher temperature? Why? Reference: C.I.S. T43
g Conditions of atmosphere and temperature differ on the Earth and Mars.	
Skills: Observing, Predicting.	1. Students predict how the temperatures and atmospheres of the Earth and Mars might compare.
Observing, Comparing.	2. Students read to check their predictions. Reference: C.I.S. S82-86
Observing, Communicating, Predicting.	3. Questions to discuss: • How do we know what the surface of the Earth is like? • How do we know about the surface of Mars? • What must happen before we are sure? • Where are the Earth's polar caps? • Where are those of Mars? • What do scientists think about them? • Why don't they know? • Why do we think Mars changes color? References: C.I.S. T44-45 S.M.A. Bk. 4 S260-261
h. The periods of rotation and revolution of Earth and Mars differ.	
Skills: Inferring, Predicting.	1. Students predict how the periods of revolution and rotation might compare. Reference: C.I.S. S82-86
Observing, Comparing.	2. Students check their predictions by reading. Reference: S.M.A. Bk. 4 S260-261
Quantifying, Formulating models.	3. Using previous equipment have students move the Earth and Mars around the lamp — "the Earth" making two revolutions while "Mars" makes one. Reference: C.I.S. T44-45
Observing, Comparing.	4. In what ways are Mars and Earth alike? Different? Reference: C.I.S. S87-88
Communicating.	5. Write creative stories about a trip to Mars.
Communicating.	6. Make a Marscope. Reference: S.M.A. Bk. 4 T103
	Media: *The Solar System and Space Travel for Grades V to IX*, Milliken, 1966: [ ] *"The Sun" and "The Solar System"*, p. 1 [ ] *The Sun — Source of Our Energy*, p. 2. [ ] *Mercury and Venus*, p. 3 [ ] *The Earth*, p. 4 [ ] *The Moon*, p. 5 [ ] *Mars and Its Moons*, p. 7 [ ] *Jupiter and Saturn*, p. 8 [ ] *Uranus, Neptune, and Pluto*, p. 9 [ ] *Day and Night*, p. 12 [ ] *Types of Rockets*, p. 15 [ ] *Rocket Launching*, p. 16

[ ] *Type of Satellites*, p. 17
[ ] *Man in Space*, p. 18
[ ] *Project Mercury and Gemini*, p. 19
[ ] *Projects Apollo. The Earth, Sun and Stars—Primary*, p. 12
[ ] *Earth Motions*, p. 2
[ ] *Moon*, p. 11
[ ] *Gravity*, p. 10
[ ] *Shapes of the Moon*, p. 12
[ ] *The Sun*, p. 13
[ ] *The Sun's Family*, p. 14
[ ] *Exploring Space*, p. 20

i. In order to support life like that on Earth, planets must have certain environmental conditions.

Skills: Observing, Communicating.

1. Class discussion about the needs of plants and animals living on the earth. (Schemes C and D).

Reference: C.I.S. S78-80

Classifying, Communicating.

2. Could these needs be met on Mars, Mercury, or Venus?

References: C.I.S. T46 S.M.A. Bk. 4 S259-261

Observing, Comparing.

3. Why might we call Venus a mystery planet, an evening star, or the Earth's twin?

Reference: C.I.S. S89-92

Comparing, Inferring.

4. What is one big difference between a star and a planet?

Reference: C.I.S. T46

Media: Non-Projective Materials:
— Universal Map of Outer Space, Rand McNally.
— Classroom Planetarium.
— Solar System Mobile.
— Map showing the moon's surface, names of craters, etc.
— Pictures from Life Magazine, Weekly Readers, and daily papers showing accounts of recent space trips: Apollo XI etc.

j. Size and position of planets determine the conditions prevailing on them.

Skills: Observing, Communicating.

1. Students report on the conditions prevailing on the outer planets — Saturn, Jupiter, Uranus, Neptune, and Pluto.

References: C.I.S. S93-96 S.M.A. Bk. 4 S261-263

Inferring, Predicting.

2. What determines the temperature of the planets?

Observing, Communicating.

3. Students do research work to determine how the planets were named.

Communicating, Formulating models.

4. Students make a play about the sun's family and design cardboard pictures to put in front of them. This could be done in the gym or outside where "planets" could rotate as they revolve about the sun.

k. The telescope has extended our knowledge about the moon.

Skills: Observing, Interpreting data, Communicating.

1. Ask students about recent spacecraft trips. Has a rocket ever gone to the moon? Has a man ever gone to the moon? What did Apollo VIII find out about the moon? What more did Apollo XI provide?

Reference: C.I.S. S97, Bk. 2 T134

Observing, Interpreting data, Communicating.

2. How did scientists study the moon before there were rockets? How are telescopes used in taking pictures of the moon? Who made the first telescope?

Reference: S.T.W. T34

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Comparing, Interpreting data.	3. Students view distant objects through field glasses, opera glasses or monoculars, etc. Reference: S.T.W. T48
Experimenting, Formulating models.	4. Make a simple refracting telescope: Use a small thick convex lens, a large thin convex lens, two cardboard tubes (one to go inside the other), glue or clay and a cork. Reference: S.M.A. Bk. 4 S241
l. Rockets carry instruments and people into space so that objects in the sky can be observed more clearly.	
Skills: Observing, Inferring.	1. Collect and observe pictures taken out in space, e.g., the earth taken from Apollo VIII or XI. Why are pictures like this taken out in space? References: C.I.S. S97-98, S104 S.M.A. Bk. 4 S204 S.T.W. 31
Skills: Observing, Predicting, Interpreting data.	2. Jump off the ground. Why do you come down again? What must a rocket engine do to get off the ground? References: C.I.S. Bk. 2 T134 S.T.W. T49-51
Observing, Comparing, Inferring.	3. Collect pictures of rockets used in recent launchings of spacecraft.
m. The motion of the moon and its relative position to the earth and sun cause it to appear in phases.	
Skills: Observing, Comparing, Communicating.	1. Review ideas learned in Grade II and repeat the investigation with the orange and flashlight. Reference: C.I.S. Bk. 2 T132-133
Interpreting data, Formulating models.	2. Groups of three students demonstrate "The Path of the Moon" as the moon moves. How much of its lighted side can be seen for the earth? Reference: C.I.S. S97-100 S.M.A. Bk. 4 S257
Observing, Interpreting data.	3. Discuss: Is the same side of the moon always towards the earth? From the earth can we see the other side of the moon? When do we see a full moon, etc.?
Observing, Formulating models.	4. Cut out eight large, black discs. On the same night each week, observe the moon to find out what part of "our" side is lighted. Show the lighted area each time by coloring a black disc with yellow chalk. Mount and date the discs. Reference: C.I.S. T50
Observing, Comparing, Interpreting data.	5. Make a chart of the moon's phases by cutting the shapes from a calendar.
Demonstrating.	6. Demonstrate the moon's phases, using a commercial planetarium.
n. Conditions of the moon are related to its mass.	
Skills: Observing, Interpreting data, Predicting.	1. Discuss space exploits and pictures of astronauts and spacecraft: What problems are there in getting to the moon? What problems are there in landing? What problems are there in returning to Earth? What do astronauts take with them? How do they dress? Why? Reference: C.I.S. S101-104
Observing, Formulating models.	2. Construct a clay model of the moon's surface.
Observing, Communicating.	3. Visit a planetarium if possible.
Observing, Interpreting data.	4. Keep a class scrapbook about recent journeys into space. Reference: C.I.S. T51
Interpreting data, Comparing.	5. Plan a trip to the moon. How will you keep in touch with your companion?
Observing, Communicating.	6. Keep a class Science Dictionary of new words learned in this section.

GRADE IV

CONCEPTUAL SCHEME A

When energy changes from one form to another, the total amount of energy remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

tissue paper, combs, rubber bands, pie pans, soda straws, nails, hammer, "slinky" toy, tuning forks, rope, perfume, plastic dishes, pail, mirrors, test tubes, electric light, pennies, aquarium, matches, candles, jars, polarizing filters, tumblers, ice, balloons, tape, red and blue coloring (ink), apples, potatoes, plastic bags, funnels.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⧓	Films	⊙	Records
⧓8	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **A loss or gain of energy affects molecular motion.**	Media: ⊟ *Finding out About Sounds*, S.V.E. ⊟ *Sounds We Hear*, S.V.E. ⧓ *Vibrations*, E.B.F.
a. Sound is caused by a vibrating object.	Reference: *Elementary Teacher's Classroom Science Demonstration and Activities*, D. Hennessy (Prentice-Hall) pages 288-296.
Skills: Observing, Interpreting data, Inferring.	1. Have pupils place tissue over a comb and hum with their lips against the tissue. What happened? Can you feel the vibrations? References: C.I.S. pp. 4-8 S.T.W. T172-176
Observing, Interpreting data, Inferring.	2. Stretch a rubber band around a pie tin. Pluck the rubber band with a finger so that it makes a sound. What does the band do while you hear the sound?
Observing, Interpreting data, Inferring.	3. Strike a note on an instrument. What is happening? Why? Feel the air directly above the string as it vibrates. Keen, *How and Why Wonder Book of Sound*, pp. 7-8. Geo. MacLeod, Toronto.
b. The pitch of sound depends upon the rate (frequency) of the vibration.	Media: ⊟ *Sound*, E.B.F. ⧓ *Waves on Water*, E.B.F. ⧓ *Science of Musical Sound*, Academy ⧓ *Evidence of Molecules and Atoms*, E.B.F. ⧓ *Explaining Matter, Atoms, and Molecules*, E.B.F. ⧓ *Vibrations*, E.B.F.
Skills: Interpreting data.	1. Flatten one end of a soda straw. Cut to make a point. Blow through the straw. As the flaps inside your mouth vibrate, cut off short bits from the other end of your straw. Why does the pitch rise as the straw is shortened? Reference: C.I.S. T9-11
Observing, Hypothesizing.	2. Put eight nails, each a different height, on a board. Hit each nail with the end of a pencil. What happens to the sound as the nails become shorter?
Interpreting data.	3. Compare the sounds from each of the strings on a guitar.
c. Sound travels in waves by molecular motion.	References: *Energy in Waves*, Ch. 3, N.S.T.A. *The Sounds You Hear*, Thinking Ahead in Science Series, American Bk. Company. Freeman, *Fun With Experiments*, Random House, p. 36.
Skills: Formulating models, Observing.	1. Touch a vibrating tuning fork to water in a bowl. How does the water behave? References: C.I.S. T9-11 S.T.W. T177-179
Formulating models, Formulating hypotheses.	2. Stretch a "slinky" toy between two chairs. When the "slinky" is motionless press two end coils together and release them quickly. What happens?
Formulating models.	3. Lay a piece of rope out straight on the floor. Take one end of the rope and move it quickly up and down until a wave motion is set up.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
d. The molecular theory explains the behavior of a sound in a solid, liquid, and gas.	
Skills: Observing, Inferring.	1. Put a few drops of perfume on a saucer. How does it spread to the children? Relate to sound, using ideas of molecules. References: C.I.S. T11-13 S.T.W. T179-180
Observing, Interpreting data.	2. Students put head (with ear downward) on one side of desk and then tap gently on the other side of desk. They then lift heads above desk level (but in the same relative position) and tap gently again. Have students write down observations and conclusions.
Observing, Inferring, Hypothesizing.	3. Experiment in bathtub can be done by placing the ear under water and gently tapping two objects together. Then lift ear out of water and repeat.
Interpreting data.	4. Discussion a few days later. Students generalize that sound travels better in solids and liquids than in gases. Why.
e. An echo is caused by the bounce of sound.	Media: *Finding Out About Sound*, S.V.E. References: *How and Why Wonder Book of Sound* *Energy in Sound Waves*, pages 49-50
Skills: Predicting, Communicating.	1. Shout into a large pail. What happens? References: C.I.S. pp. 13-15 S.T.W. pp. 188-193
f. Some substances reflect sound better than others.	
Skills: Observing.	1. Make two clapping sticks and test clapping sounds against various substances (wooden walls, cement walls, etc.)
g. Objects become visible as light is reflected from them to the eye.	Media: *Light and How it Travels*, J.H. *Light and What it Does*, E.B.F.
Skills: Observing, Interpreting data.	1. Have a child enter a dark closet. Give him a pencil. Then ask him what color the pencil is. Will he be able to tell you? References: C.I.S. T21-23 S.T.W. T200-202
Observing, Communicating.	2. Hold a mirror to a dark page of a book in the light. What happens to the dark page? Hold a sheet of white paper to a dark page in the light. Hold a sheet of black paper to a dark page in the light. How does light behave?
Observing, Interpreting data.	3. Stand a pencil on a sheet of white paper and focus a light on the pencil. Move the light around the pencil. What do you notice about the shadow as the light is moved around the pencil?
Observing, Hypothesizing, Interpreting data.	4. Arrange five test tubes, two with two shades of red water, two with two shades of blue water and one with clear water, from lightest to darkest. Place a piece of brightly colored paper at the far end of a shoe box. Direct a flashlight through a hole in the top of the box. Look at the test tubes, then look at the colored paper inside the shoe box through a hole in the other end of the box. What colors do you see?
h. Light, sound and electricity are different forms of energy.	Media: *Light and How It Travels*, J.H. *How To Bend Light*, E.B.F. Reference: *Energy in Waves*, Ch. 5, N.S.T.A.
Skills: Predicting, Inferring, Hypothesizing.	1. Use a straight tube of cardboard. Place an electric light at one end. Can you see the light? Speak softly into the tube. Can you hear the voice? Bend the tube and repeat the above. Can you still see the light? Can you still hear the voice? References: C.I.S. pp.23-25 S.T.W. T200
i. Light may be bent as it passes through certain materials; it may be reflected off a surface.	
Skills: Interpreting data.	1. Put a penny into a dish. Look over the edge of the dish so that the penny just disappears. Slowly add water to the dish. What happens? References: C.I.S. T26-29 S.T.W. T208-209, T212-215

Concepts and Subconcepts	Suggested Activities and Instructional Materials
	Media: *How to Bend Light,* E.B.F.
Inferring, Predicting.	2. Fill an aquarium tank with water. Add a few drops of milk, to make it cloudy. Make a room dark. Shine a flashlight on a mirror at bottom of tank. What do you see?
j. Light energy may be released by a chemical change.	
Skills: Interpreting data.	1. Use the striking of matches to show that a chemical reaction produces light.
	References: C.I.S. T27-29. *Energy in Waves,* Ch. 5
Predicting, Inferring.	2. Mark inches and half inches on a candle with a pencil and ruler. How long does it take for half an inch of paraffin to disappear? What happens to the paraffin? How long would it take for the entire candle to burn?
Inferring, Interpreting data, Defining terms.	3. Stick a short candle in the bottom of a jar with melted wax. Blow out the flame and pour about an inch of clear limewater into the jar. Light the candle. Place a second dry jar over the mouth of the first jar. What happens to the flame? Join the jars together with tape, not letting air in. Shake the chamber gently to mix the limewater and the air. What happens to the limewater?
k. Light energy behaves sometimes as waves, sometimes as particles.	
Skills: Predicting, Inferring.	1. Look through a piece of polarized plastic. Does light pass through? Place one piece on the other and look through both. Does light pass through now? Turn one of the pieces holding the other one still. What happens as one of the pieces is turned?
	Reference: C.I.S. T30-31
l. Heat causes water to evaporate and to become a gas.	
Skills: Inferring.	1. Put a drop of perfume on a dish and leave it for a few minutes. Put a drop of water on a dish. Where did the drops go?
	Reference: C.I.S. pp. 66-70
Observing, Inferring, Interpreting data.	2. Put a drop of water in a glass. Tape another glass over the first. Let the glass chamber stand in a warm place. What happens to the drop of water?
m. To condense water vapor heat energy must be taken away.	
Skills: Inferring.	1. Breathe on to a mirror. Where does the damp spot come from? Where does it disappear to?
	Reference: C.I.S. T42-43
Inferring.	2. Place ice and cold water in a shiny tin can. What happens to the shiny surface? Where did the water come from?
n. As molecules of air and water are heated, their movement increases and they occupy more space.	
Skills: Interpreting data, Communicating.	1. Put a few drops of water in each of two bottles. Put a balloon over each. Place one bottle in a pan of warm water and the other in a pan of cold water. What happens to each balloon? Exchange the bottles and pans. What happens? Why does this occur?
Interpreting data.	2. Place a pop bottle that is almost full of cold water into a pan of hot water. What do you observe? Explain.
o. Rising air cools and its water condenses to form a cloud.	
Skills: Interpreting data.	1. Pour about an inch of water into a glass. Tape another glass over it. Put the sealed glass chamber on a warm radiator or in a warm place. What happens to the upper part of the chamber?
	Reference: C.I.S. T44-45

Concepts and Subconcepts	Suggested Activities and Instructional Materials
p. Rain forms as cloud droplets come together into larger droplets of water.	
Skills: Formulating models.	1. Take two large jars. Fill one with cold water and one with warm water. Put some blue ink in a small jar of cold water and red ink in a small jar of warm water. Pour a small amount of the red ink from the other small jar into the large jar of cold water. What happens to the red ink? Make a model. Reference: C.I.S. T46-47
q. Warm water rises because it expands.	
Skills: Observing, Hypothesizing, Quantifying.	1. Put an apple and a potato in a plastic bag. Weigh both the apple and the potato separately. Cut up the apple and potato into small pieces and place each in a small pan open to the air. Weigh each every day for three days and record the weight each day. What is the weight loss from each? What did both the apple and potato lose and where did it go? Reference: C.I.S. T47-49
r. Water is a component of all organisms.	
Skills: Observing, Formulating hypotheses.	1. Mix about an inch of garden soil in a quart jar of water. Let it stand for awhile. What happens to the soil particles? Place some cotton in a funnel and put about an inch layer of sand over the cotton. Put the funnel in a clean beaker. Slowly pour some water from the settling jar into the funnel. What happens to the water in the funnel? Reference: C.I.S. T49-50
s. Water supply is the result of the cycle of evaporation and condensation.	
Skills: Observing, Inferring, Hypothesizing, Formulating models.	1. Put 2 or 3 inches of rich soil into a large jug. Lower several tropical plants into the jug and anchor them into the soil. Water well and cork the top. What happens each afternoon? Reference: C.I.S. T50-52

GRADE IV

CONCEPTUAL SCHEME B

When matter changes from one form to another, the total amount of matter remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

tumblers, soft drink bottle, vinegar, baking soda, cork, test tubes, yeast, hydrogen peroxide, steel wool, plastic bags, green plant (elodia)

SUPPLEMENTARY REFERENCES

Johnstone, A. H. and T. L. Morrison, *When Chemistry Takes Shape, Book 1.* London: Heinemann Educational Books Ltd.

National Science Teachers, *Investigating Science With Children, Vol. 3, Atoms and Molecules,* Chapter 2.

Code for Media:

⋈ Films

$⋈_8$ Film Loops

⊟ Filmstrips

⊙ Records

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S.M.A. — *Science, A Modern Approach,* Holt, Rinehart.

S.T.W. — *Science for Tomorrow's World,* Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **In chemical change, atoms react to produce a change in the molecules.** a. Substances have properties that distinguish them from one another.	1. What will happen if a tumbler is pushed under water while the tumbler is held upside down? Observe the result. Discuss properties of air. References: C.I.S. T58 S.M.A. Vol 3, T86

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Hypothesizing, Inferring.	2. Do the following teacher demonstration without comment: Fill soft drink bottle about ⅓ full of vinegar solution (1 tbsp. vinegar to 1 cup of water). Wrap 1 teaspoonful of baking soda in a napkin. Tie thread around napkin and suspend by fitting a cork to neck of bottle. Close bottle fairly tightly. When generator is set, invert bottle momentarily. Point bottle toward ceiling. (Sometimes cork will pop out with great force.) Ask, "Are there any questions?" Bring out idea of chemical change. Media: *Explaining Matter and Chemical Change*, E.B.F. *Air Around Us*, E.B.F. *Atomic Energy Inside the Atom*, E.B.F.
b. A substance may be recognized by its properties. Skills: Observing, Interpreting data, Communicating, Hypothesizing.	1. With a pencil, push a wad of steel wool into the bottom of each of two small test tubes. Fill one test tube with water to the top. Place a finger over the top, not to let any water out, and invert the test tube into a beaker of water. Put a few grains of yeast in the other test tube. Fill it full with hydrogen peroxide and cover the top with finger quickly. Invert this test tube into another beaker of water. Watch the bubbles of gas collect in the top of the tube. Let out some of the water in the first test tube so that the steel wool is in air. Observe the steel wool during the next few days. What happens to the steel wool in oxygen? In air? References: C.I.S. T59 S.M.A. Vol. 3, T82 Media: *The Composition of Air*, J.H.
c. Molecules in element are alike; the molecules in a compound are different.	1. Use models of styrofoam balls, toothpicks, or other items to represent atoms of various elements and compounds. Combine them in various ways, noting molecules formed. Reference: C.I.S. T62
d. Molecules of substances interact. Skills: Observing, Communicating, Inferring.	1. Fill a glass full of water and hold a square of hard plastic over it. Invert the jar into a pan of water. Let the plastic fall away. What happens to the water in the jar? How could the water in the glass be lowered without removing the glass from the water? Tie a hose to a plastic bag. Blow the bag full of air. Place the free end of the tube in the mouth of a jar under water. Squeeze the plastic bag. Where does the air go? What happens to the water in the bottle as air is squeezed out of the plastic bag? Reference: C.I.S. T64
e. Substances in air are affected by the action of green plants. (Green plants give off oxygen in light and take in carbon dioxide.) Skills: Observing, Communicating, Inferring.	1. Place one green plant under a glass jar in light. Place another green plant under a jar in a dark place. What happens to the plant in the dark. Why? Reference: C.I.S. T69 2. Place a funnel over an elodea plant and place a test tube over the funnel. What happens? 3. Let some elodea plants float on the water of an aquarium with fish in the sunlight. What do you see? Shut off the sunlight with a piece of cardboard. What happens to the bubbles when light is cut off?

GRADE IV

CONCEPTUAL SCHEME C

Living things are interdependent with one another and with their environment.

SUGGESTED MATERIALS AND EQUIPMENT

fish, mouse, mealworms, ants, cactus plant, elodea plant, soil, beakers, part of a live tree, lima bean seeds, onion cells, bread, hand lenses, microscopes, agar solution.

SUPPLEMENTARY REFERENCES

Clarke, et al., *Biology by Inquiry*. London: Heinemann Educational Books, 1968.

Eckert, A. W., *The Wild Season*. New York: Little, Brown and Company, 1967.

King, Allan and Donald Bank, *Search and Discover*. Toronto: Clarke, Irwin and Co. Ltd., 1967.

MacCracken, Helen, *Science Through Discovery*. (Singer Science Series). Don Mills, Ontario: J. M. Dent, 1967. (A good reference for this Conceptual Scheme.)

National Science Teachers' Association, *Investigating Science With Children*, Vol. 1, *Living Things*, 1965.

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Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Living things capture matter from the environment and return it to the environment.**	
a. Livings things are dependent upon a particular environment; they are adapted to different environments. Skills: Observing, Inferring, Communicating.	1. Observe the following living things and discuss with the class the means by which each animal lives in its environment. Also discuss what would happen if these creatures traded places: • Fish • Mouse • Budgie Bird • Mealworms • Ants 2. Compare a cactus plant and a geranium. What would occur if they were not watered for several days? Why? References: C.I.S. T80 S.M.A. T63, pp. 81, 149-201 S.T.W. pp. 76-77
b. Green plants get the matter for growth from water, soil, and air. Skills: Observing, Inferring, Predicting, Hypothesizing.	1. After reading pp. 140-142 in C.I.S. on the scientist and the willow tree, ask: "Why did Van Helmont plant the willow in a tub of soil? After five years, did the soil lose as much weight as the willow tree gained? What does this suggest? What else, besides water, must a plant have to make food?" Reference: C.I.S. T83 2. Pour some distilled water into the garden soil and shake it. Let the mixture stand overnight. Pack cotton into the funnel to act as a filter. 'Evaporate the water in the beaker. Is anything left in the beaker? Where did it come from? Did the soil contain substances that could dissolve in water? What other substances will dissolve in water? Media: *Balanced Aquarium*, E.B.F. *Hybernation and Other Forms of Dormancy*, E.B.F. *Plants and How They Grow*, S.V.E. *Plant Factories*, S.V.E. PK-3488 *How Green Plants Grow*, J.H. Reference: S.T.W. pp. 62-77 pp. 90-95
c. Using energy from light, green plants make their foods from inorganic substances in the environment. Skills: Observing, Inferring, Investigating, Analyzing.	1. Conduct investigation as shown in teacher and pupil references C.I.S. Reference: C.I.S. T85, p. 150, pp. 66-77 Media: *Plants and How They Grow*, S.V.E. *Plant Factories*, PK-3488 *Green Plants and Sunlight*, E.B.F., TK-2021
d. Matter from the environment is used for growth by cells of green plants and all other living things.	1. Discussion: How does a tree grow? Consult book, C.I.S., pp. 152-154 Reference: C.I.S. T85, pp. 90-96 Media: *How Green Plants Grow*, J.H.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
	2. Investigation: Plant lima bean seeds in pots. When about 2" high, put black mark on stem 1" above ground. What happens? What happens to mark? What happens to plant? 3. Examine under a microscope, onion cells and human cheek cells. Compare. 4. Observe picture on page 153, C.I.S. Did the height of nail above ground change? What change did you notice in the nail? Discuss.
e. Through the action of bacteria and other organisms, the matter of once living things is returned to the environment.	1. Take a field trip to observe how a tree changes the environment of other living things. When a tree dies, does it stop being useful? Reference: C.I.S. T91 2. Place a piece of bread in jar. Put in warm place but out of sunlight. Observe every day. What happens to bread? Examine under magnifying glass and microscope. Media: ⧓ *The World of the Invisible*, E.B.F. 3. Is mould different from green plants? Of what use are fungi? Reference: S.T.W. pp. 79-80 4. Take a little garden soil and divide into two lots. Bake one lot in an oven at 400° F for 1 hour. Place some sterilized soil into one dish containing agar solution and fresh soil into another. What do you see in 3 to 4 days? Examine colonies with a microscope.
f. A living thing is dependent upon all the conditions and all other living things in its environment.	1. Investigate (with controlled experiments) the effects of water, temperature and light on mould and bacteria. 2. Collect specimens of plants and small pond life from a variety of habitats. Place together in an aquarium. Observe, then observe again at periodic intervals. What changes have taken place? What part does each animal play in the community? Media: ⊟ *Plant and Animal Relationships*, E.B.F., PK-4358-4363 series 3. Set up a desert terrarium.
g. Man protects some plants from unfavorable temperatures and from natural enemies.	1. Discussion: What would happen to the animals in the zoo if they were released into neighboring woods? Why? Similarly, what would happen to the exotic plants raised in a greenhouse if they were planted outdoors locally? Can plants and animals live without each other? 2. Using the concepts learned, have the children design a spaceship community in which man can live independently. What would man take with him? Media: ⧓ *First Men Into Space (Solving the Space Survival Problems)*, E.B.F.

GRADE IV

CONCEPTUAL SCHEME D

A living thing is the product of its heredity and environment.

SUGGESTED MATERIALS AND EQUIPMENT

heat lamp, jars, magnifiers, thermometers, vials, tumblers, aquarium, gold fish.

Teacher Reference:

Carin, A. and R. B. Sund, *Teaching Science Through Discovery*, Ohio: C. E. Merrill Books Inc., 1966.

SUPPLEMENTARY REFERENCES

Atkin and Burnett, *Working with Animals*, (Elementary School Science Activities Series). Toronto: Holt, Rinehart and Winston, 1959.

Beauchamp, Wilbur, et al., *The Basic Science Program — Book 6*. Scarborough: Gage.

Eckert, A. W., *The Wild Season*. Little, Brown and Co., 1967.

Hennessy, David E., *Elementary Classroom Science Demonstrations and Activities, Chapter II*. Scarborough: Prentice-Hall. *(The How and Why Wonder Book of Birds)*.

Salt, W. R. and A. L. Wilk, *The Birds of Alberta*. Edmonton: Queen's Printer, 1958.

Code for Media:

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S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

1. **A living thing reproduces itself and develops in a given environment.**

   a. Living things depend on other living things for food, in food chains that in the end depend on green plants.

1. Collect some daphnia (water fleas) from a nearby pond. (They are found in almost any quiet pool, slough or stream where green algae is growing.) Keep them in an open jar filled with "soupy water". If placed in an aquarium where green algae is growing, they will eat much of the algae. When fish are introduced, they in turn feed from the daphnia. Discuss food chains, e.g., polar bear, hay - field, mouse - cat.

References: C.I.S. T98, p. 175 S.T.W. T60-61

Media: *Hand Lens and Microscope Techniques,* E.B.F.
Plant and Animal Relationships, E.B.F.

Skills: Observing, Hypothesizing, Predicting, Communicating, Formulating models.

2. Read to the class excerpts from stories (fiction or non-fiction) depicting the balance of nature. For example, discuss "The Wild Season".

   b. Every species of animal has a life cycle in which the same pattern of development is repeated over and over again.

1. Collect caterpillars or cocoons with the plant material on which they are found, and observe the various stages of growth and development. Label each and place in a separate container. Place containers outside in the fall. (Be sure they are in a safe place.) Observe them in early spring for completion of cycle.

Reference: C.I.S. T106

Skills: Observing, Hypothesizing, Formulating models, Classifying, Interpreting data.

2. Observe mealworm (weevil) cycle four to five months as it changes to form the Tenebrio Beetle.

Media: 8 *Life Cycle of the Ladybird Beetle*
Life Story of a Water Flea, E.B.F. TK-1895
The Monarch Butterfly Story, E.B.F. TK-1701
Life Story of the Snail, E.B.F. TK-1888
Life Story of the Paramecin, E.B.F. TK-1887

   c. The life cycle of an animal is adapted to the special environment of habitat.

1. Observe frogs in a terrarium or catch from a pond several tadpoles and observe their development.

2. Obtain from a pond, water containing mosquito larvae. How is the larvae adapted for survival?

Skills: Observing, Interpreting data, Formulating models.

3. Using a magnifying glass, investigate the body of the mealworm to find out how it is adapted to living in bran.

   d. Different animals (salmon and duck) are adapted to different special environments.

1. Make a study of birds by field trips, visual materials and books to discover their adaptations to their variety of environment, e.g., variations in feet, bills, etc.

Reference: C.I.S. T108, T175

Skills: Interpreting data.

Media: *The Fresh Water Pond,* E.B.F. TK-1564
Animal Town of the Prairie, E.B.F.

   e. In both structure and behavior the duck is adapted to its environment.

1. Observe ducks on a farm or at the zoo to note their strange feet. Note further that some are suited to diving and some are not, i.e., types of bills. What other structures of the duck make it suited to its environment?

Skills: Interpreting data, Formulating models.

Media: *Bird Homes,* E.B.F.

   f. All organisms have inborn behavior that adapts them to their environment.

1. Investigate behavior of mealworm towards light, heat, and water . . .

2. Study migrating behaviors of birds.

Skills: Observing, Controlling variables, Quantifying, Formulating hypothesis.

3. Investigate opening and closing of mouth of fish in relation to temperature changes. Have pupils hypothesize in advance of investigation what will happen. Investigate the responses of fish to color, light, intensity changes, sound, . . .

Media: 8 *Venus Flytrap: Reaction to Stimulus,* E.B.F.
8 *The Seashore — Plant and Animal Adaptations,* E.B.F.

GRADE IV

CONCEPTUAL SCHEME E

Living things are in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

aquarium, sand, several disposable glass jars, rock, balloon, pop bottles, alcohol burners, thermometers, tongs, ice, balloons, tempera paint, vials with caps, glass squares, rubber bands, radish seeds, balance, soil, tube of toothpaste, modelling clay, bar of soap.

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Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. The environment is in constant change.	
a. The energy of moving water changes the earth's surface.	1. Allow a garden hose to run on an area of hard earth for several minutes. What happens? Reference: C.I.S. pp. 220-224
Skills: Observing, Hypothesizing.	2. Pile sand at one end of aquarium to make a hill. Make a groove down hill. Make clear area at bottom on floor of aquarium. Sprinkle water gently on hill to make stream run down groove. What happens to some sand? Where does it go? First pour water slowly, then faster. What difference do you see in the sand? Media: ⊟ *Changing the Face of the Earth,* Dept. of Education Film, S.V.E. PK-4275
b. The expansion of freezing water breaks down rocks.	1. Fill several jars with water. Put on lids and freeze them. What happens?
Skills: Hypothesizing, Predicting, Testing, Observing.	2. What would happen to a rock with cracks in it if water were frozen in and around it? Find several cracked rocks and freeze with water in the cracks. What happens? Media: ⊟ *Wind and Waves,* S.V.E. PK-4278 ⋈ *Erosion — Levelling the Land,* E.B.F. TK-1756 ⋈8 *Sediment Deposition*, E.B.F.
c. The expansion and contraction of rock, and the force of growing plants, help break down rock.	1. Hold a piece of shale in hot flame. After rock becomes hot plunge into can of ice water. What happens to rock? Why do bits of rock break off? Discussion: How can just the heat of the sun split a rock? Media: ⋈ *The Earth in Change,* E.B.F. 2. Tie balloon lightly over neck of bottle. Heat bottle. Balloon gets bigger. Cool. Balloon gets smaller. What does this tell you? Heat liquid in a thermometer, then cool. What happens? 3. Coat several inflated balloons with paint. When dry, release some air. What happens? Why? What is another way of making a substance contract? How can this be compared to rocks? 4. Fill vial with dry beans. Add water. Put cap on. Put bottle in paper bag to keep seeds dark. In two or three days observe. What has happened to cap of bottle? What has happened to beans? Reference: C.I.S. pp. 229-230 5. Investigation — What happens when plants grow? Put blotter on piece of glass. Put seeds on blotter. Place second piece of glass on top of seeds. Put rubber bands around this sandwich. Stand in a pan with a little water in bottom. Watch roots. What happens? Reference: C.I.S. "The Force of a Plant", p. 230
d. Land worn down in one place is built up in another.	1. Investigation — into moving water. Put about one inch of sand into a jar. Add water to about three parts full. When sand has settled begin to stir water gently. Observe. How much sand is carried along? Now stir water faster. Now stir faster. Still faster. What happens to amount of sand carried as water moves faster? Take spoon out of water quickly. What happens to the water? What happens to the load the water is carrying? Do the heavier particles or the lighter drop out first?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
e. Plants reduce erosion.	1. Line three shoe boxes with foil. Cut slot at one end of each box. Fold other pieces of foil into spouts for each slot. Fill each box with equal amount of soil. Leave soil in one box bare. Cover soil in second box with grass sod. Cover third box with leaves or leaf mold. Using sprinkler, cover each box with an equal amount of water. Which produces a muddy stream? Why is the water muddy? How does the water from other spouts look? How do you explain the difference? How do plants and leaves keep water from carrying soil? Reference: C.I.S. pp. 240-244 2. Plan a trip to a place where water has washed away soil. Observe and question. Be sure to take along a hand lens. Examine network of tiny root hairs. 3. How leaves help to hold soil. Make a flat pile of sand on brick or block in aquarium. Lay paper leaves on sand. Sprinkle with water. The higher the can the harder the water will fall. What happens to sand under leaves? What happens to sand not covered?
f. Pressures on and in the earth cause mountains to rise.	1. On an equal balance or pan scale, balance a pan of water opposite a pan of soil; the water represents the ocean and the soil the mountains. If sand is shifted into the sea, mountain pan rises. Reference: C.I.S. pp. 245-248 2. Take a partly used tube of toothpaste. Squeeze one end. What happens at the other end? Compare this to the sediment pressing down in one place and land rising in another. 3. Investigation: Squeeze clay in hands. What happens? How do these ridges refer to how a mountain may be built up? Media: *The Story of Mountains*, PK-2744 *Volcanoes and Earthquakes*, S.V.E. PK-4279 *Mountain Building*, E.B.F. *Volcanoes in Action*, T-217 *How Mountains are Formed*, S.V.E. *Glaciers and Their work*, Curr.

GRADE IV

CONCEPTUAL SCHEME F

The universe is in constant change. The motion and path of celestial bodies are predictable.

SUGGESTED MATERIALS AND EQUIPMENT

balls, flashlight, string, masking tape, yardstick.

SUPPLEMENTARY REFERENCES

Pupil Reference:

Highland, Harold, *The How and Why Wonder Book of Planets and Interplanetary Travel*. New York: Wonder Books, Inc.

Teacher References:

N.S.T.A. *Investigating Science With Children — Vol. 6, "Space"*, (Chapter 2), 1964.

Pogreen, John and Cathleen. *The Earth in Space*. New York: Random House Inc., 1963

Rey, H. A. *The Stars*. Boston: Houghton Mifflin Co., 1967.

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S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **The Motion and Path of Celestial Bodies are Predictable.** a. The changing shape of the moon is due to its motion around the earth. Skills: Observing, Formulating models.	1. Investigation — In a dark room a person holds a flashlight on you. Hold a ball in your hand. Turn slowly so that a ball moves in a circle around you. Keep ball out of shadow. What happens to shape of the lighted part of the ball? Hold a ball in front in line with light — observe. Turn quarter circle to right, observe ball, then turn same again, and again. Observe the ball in all four positions. Draw the shape of lighted part of the ball. Why does the shape of lighted part of the ball change? Does the shape of the ball change? Why does the shape of the moon seem to change?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
	Reference: C.I.S. pp. 256-260 Media: ⋈ *A Trip* to the *Moon,* E.B.F ⋈ *The Moon,* E.B.F. T-209
	2. Observe the moon as it passes through its phases; pupils observe on their own at night.
b. A comet, like the moon, may travel in a predicable orbit. Skills: Formulating models.	1. Making a Model — The orbit of a comet. On a large clear area, make a scale model of part of the solar system. Mark spot for the sun in the center. Draw circles to represent orbits of planets in proportion. Make a loop of a string 16′ 2″ long. Tape the loop to the floor at the sun, also at the point of 15′ 8″ stretched out from the sun. Hold chalk inside loop, move the chalk along loop. It will trace an orbit like that of Halley's Comet. What shape is the orbit?
	Reference: C.I.S. pp. 264-268
c. The orbit of Halley's Comet is an ellipse.	1. Investigation — A moving ball. Tie one end of thread to a tennis ball. Hold the other end and roll ball along the floor. Keep the thread slack. Does the ball roll in a straight line or in a curve? Now, hold the end of the string in one place on the floor. Roll the ball. Keep the thread taut. Does the ball roll in a straight line or in a curve? What do you feel in the string as the ball rolls in a curve? What is needed to make a moving ball roll in a curve?
	Reference: C.I.S. p. 251
	2. Pulling on the moon (C.I.S.). Compare with investigation above. Why does the moon not travel in a straight line? What shape is the orbit of the moon? Of Halley's Comet?
	Reference: C.I.S. p. 266
d. Meteors may be fragments of disintegrated comets.	1. Observe the picture on page 270 of the C.I.S. reference. When a comet nears the sun, what may happen to some of its ice? When the ice of a comet turns to gas, what happens to the rocks? What do we call these?
	Reference: C.I.S. pp. 269-274
	2. Investigation into meteors — Watch different parts of the sky. Call out when a "shooting star" is seen. What do we call groups of meteors? Observe these things about meteors: Are they equally bright? Are they the same colors? Do they come from the same direction? Do they last the same time?
	3. What makes the light we see from a meteor? What is a meteorite?
	Reference: C.I.S. pp. 272-273
The shape of orbits and the position of bodies in space are predictable.	1. What do we mean by predict? Why are scientists able to predict?
	2. What makes Halley's Comet come back? Why can this path of the comet be predicted? What other things affect the arrival of the comet?
	References: C.I.S. pp. 274-276 S.M.A. T97-98
	Media: ⋈ *A Trip* to the *Moon,* E.B.F. ⋈ *Planets in Orbit,* E.B.F.

GRADE V

CONCEPTUAL SCHEME A

When energy changes from one form to another, the total amount of energy remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

equal arm balances, paper cups, spoons, weights, balloons, soda straws, wire, medicine droppers, string, marbles, elastic bands, rulers, thumbtacks.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

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⊙ Records
●__● Tapes
[ ] Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. Energy must be applied to produce an unbalanced force, resulting in motion or change of motion. a. To move an object, energy must be applied to overcome the pull of gravitation.	Media: ⊟ *How Gravity Works* ⊟ *How Do Jets Fly?*, J.H. ⊟ *Rocket Power for Space Travel*, J.H. ⊟ *The Earth As a Planet*, N.E.B. ⊟ *Space Travel 2000 A.D.*, S.V.E. ⊟ *The Earth and Its Motions*, Eye Gate ⊟ *What Are Space Stations?*, J.H. ⊟ *Our Neighbor The Moon*, J.H. ⊟ *Our Earth is Moving*, Curr.
Skills: Formulating hypotheses, Predicting.	1. Set a paper cup on one pan of an equal arm balance, and a weight on the other. With a spoon, put enough sand in the cup to make it balance the weight. Take off the weight. What happens to the cup of sand? Why? References: C.I.S. T52 S.T.W. T275 2. Put strings through the sides of a paper cup. Lift the cup of sand with a spring balance. How much of a pull is needed to act against the force of gravitation?
b. Energy must be supplied to develop a force sufficient to overcome gravitational pull.	Media: ⊟ *The Solar System*, E.B.F. ⊟ *Exploring the Moon*, J.H. ⊟ *Getting Ready for a Space Trip*, J.H. ⧓ *How Gravity Affects Us*, E.B.F. ⧓ *A Trip to the Moon*, E.B.F.
Skills: Formulating hypotheses, Interpreting data, results.	1. Blow up a long balloon, and then tape a soda straw lengthwise to the balloon. Pass a thin wire through the ends to two chairs. What will happen if the air is released? In which direction does the balloon move? Why? (theory). References: C.I.S. T54 S.M.A. T53 S.T.W. T273
Experimenting, Formulating models.	2. Make a model rocket by taking a long balloon, inserting a glass medicine dropper into the mouth of the balloon, blowing it up and tying it with a string. Fasten a paper cone to the top of the balloon. After leaning the model against books, loosen the string. Why didn't the rocket keep moving forward?
c. To alter the path of a body in space, energy must be applied to affect the relationship between gravitational pull and centrifugal force.	Media: ⊟ *Our Solar System*, S.V.E. ⊟ *Space Satellites*, J.H. ⊟ *Gravity*, McGraw-Hill ⊟ *Man's Preparation for Space Travel*, J.H. ⊟ *Earth's Nearest Neighbor*, S.V.E. ⊟ *The Sun and Its Family*, S.V.E. ⊟ *Man Becomes An Astronomer*, Walt Disney ⊟ *How Man Explores Space*, S.V.E.
Skills: Predicting, Formulating hypotheses.	1. Push a marble off the edge of a desk or table. What path does the marble take? Can you change the shape of the marble's path? Which takes the longest to fall, if the marble is pushed off with little force or great force? References: C.I.S. T56 S.T.W. T279

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Quantifying, Interpreting data, Communicating.	2. Mark off a scale in inches on your desk with a piece of chalk. Release marbles at different distances from your elastic band sling Measure the distances the marbles travel. Make a graph of your results.
d. Inertia and gravitation affect the path of bodies travelling in space.	
Skills: Formulating models.	1. Make a model solar system. Suggested scale: 9″ = 8,000 miles. Circles: Sun — 9″, Earth — 1″, Mercury — ⅜″, Mars and Pluto — ½″, Uranus and Neptune — 4″, Saturn — 9½″, Jupiter — 11″, Venus — 8″. Why do the earth and the other planets orbit the sun? Why don't the planets fall into the sun? References: C.I.S. T59 S.M.A. T69
Predicting, Interpreting data.	2. Insert two thumbtacks into a paper an inch or two apart. After putting a string loop around the thumbtacks, put a pencil inside the loop, tighten the string and draw a line. What shape is the orbit? How will the shape of the path change if you move the tacks further apart? What kind of orbit do you think the earth makes?
Interpreting data, Formulating hypotheses.	3. Divide the students into groups, having each group do library research on a particular planet or planets. Study photocopied photographs that astronomers have taken of the planets. See what can be hypothesized from the photographs and then call upon the "resource group" (the group who studied the particular planet) to report on what astronomers have concluded about the planet.
e. The position and motion of the moon are affected by gravitational and inertial motion.	
Skills: Predicting, Interpreting data.	1. Attach a yardstick with a hole in the top vertically to a chair. Drill a hole in the center of another yardstick and attach it to the vertical yardstick. To the end of the horizontal yardstick, attach a plastic sheet marked off in one-inch squares, and then aim it at the moon so that the moon seems to be sitting on the end of the yardstick. Wait for five minutes and then look along the stick. Has the moon moved? How do you know? References: C.I.S. T61 S.M.A. T59
f. Exploration of the moon depends upon understanding of how the position and motion of bodies in space are affected by gravitation and inertial motion.	
Skills: Formulating hypotheses, Defining terms, Formulating models.	1. You are a group of astronauts who are going to take a trip to the moon. How would you go about solving these problems? — Weightlessness — G forces — Food in space — Water — Danger from light — Landing on the moon — Returning to earth — Clothing you will wear. References: C.I.S. T63 S.M.A. T69 S.T.W. T286
Interpreting data and results.	2. Study photographs of the moon's surface (hills, valleys, craters, "bumps"). Will the surface affect the landing or launching of the spacecraft? What do you think it would feel like to walk on the moon? Do you see any other problems that astronauts may have?

GRADE V

CONCEPTUAL SCHEME B

When matter changes from one form to another, the total amount of matter remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

glass funnel, perfume, balloons, string, beakers, vanilla extract, chlorine water (bleach), mercuric oxide, pyrex test tubes, test-tube clamps, alcohol lamps, sugar, steel wool, vinegar, trays, iron, sulfur, magnets, litmus paper (red and blue), ammonia, limewater, rubber tubing, flasks, tincture of iodine, soda straws, potted plant, transplant plastic, styrofoam balls, toothpicks, flashbulbs (used and new).

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⋈	Films	⊙	Records
⋈8	Film Loops	●—●	Tapes
⌸	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **In chemical and physical change, the total amount of matter remains unchanged.**	Media: ⌸ *What Things Are Made Of*, S.V.E. ⌸ *Atoms and Molecules*, S.V.E. ⌸ *Chemical Changes*, S.V.E. ⌸ *Earth, A Great Storehouse*, S.V.E. ⌸ *Chemical Changes*, McGraw-Hill ⋈ *Atomic Energy — Inside the Atom*, E.B. ⋈ *Explaining Matter: Chemical Change*, E.B. ⋈8 *Breakdown of Mercuric Oxide*
a A molecule is the smallest particle of a substance which retains the properties of the substance. Skills: Formulating hypotheses, Defining terms.	1. Using a funnel, place a few drops of perfume in a balloon. Blow up the balloon, and firmly tie a knot in its neck so that no air can escape. Smell the air in a large beaker. Place the balloon in the beaker, letting it stand for 15 minutes. Remove the balloon from the beaker. Smell the air in the beaker. What do you smell? How could perfume get into the air in the beaker from inside the balloon? References: C.I.S. T28 S.T.W. T168
Controlling variables.	2. Pour a large spoonful of vanilla extract or chlorine water into separate glasses. Insert a balloon or plastic bag about one-third of the way into each glass or jar, and inflate the balloon so that it is wedged tightly into the opening to prevent the odors from escaping. Balloons should be tied with string, using a slipknot. In a third empty glass, inflate a balloon with air. Allow the investigation to stand for two or three days. Then unseal each balloon, smelling the air as it escapes. How did the odors get inside? Why couldn't you smell anything in the glass when there was no perfume or chlorine water?
b. Compounds can be broken down into the elements of which they are composed. Skills: Interpreting data, Defining terms, Inferring.	1. Heat mercuric oxide in a pyrex test tube. **DON'T BREATHE IN THE FUMES.** What happens? Explain. References: C.I.S. T31 S.T.W. T196
Formulating hypotheses, Inferring.	2. Place a glowing splint into the test tube. What happened? What is your theory? Heat sugar in a test tube. What do you see? What do you think has happened?
c. Compounds are built up from elements. Formulating hypotheses, Interpreting data, Experimenting.	1. Roll steel wool into one-inch balls and put into vinegar for about 6 hours. Rinse with water. Place a ball of steel wool into the bottom of a test tube and invert in a tray of water. Invert another test tube with steel wool into a tray containing no water. Leave for 2 or 3 days. What happens? Why? References: C.I.S. T33 S.M.A. T50 S.T.W. T193
Formulating models.	2. Place iron and sulfur together in a test tube and heat over a hot flame. Observe what happens. Test the substance with a magnet. What reasons can be given for the change after heating?
d. Compounds are grouped by their chemical properties. Skills: Formulating hypotheses.	1. Distribute strips of red and blue litmus and construction paper. Drop vinegar and household ammonia on the paper strips. What happens to the litmus paper? What happens to the construction paper? Why do you think this is so? References: C.I.S. T35 S.T.W. T179

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Interpreting data, Defining terms, Classifying.	2. Collect the following materials: lemon juice, salt water, washing soda, water, cooking oil, fresh milk, sour milk, sugar water, carbonated soft drink. Test the solutions with red and blue litmus paper. Make a chart showing how we could group these materials.
e. Chemical reactions are a dependable means of testing the presence of a substance.	
Skills: Formulating hypotheses.	1. Place some carbonated soft drink in a glass and add limewater to it. What happens? What does this show us? Reference: C.I.S. T38 S.T.W. T179
Interpreting data.	2. Place about an inch of eggshells in the bottom of a flask. Pour vinegar into the flask until it is about three-quarters full. What happens? What is forming? Do you see something being changed? Attach a delivery tube to the flask and collect the gas in test tubes that have been filled with water. Pour some limewater into a test tube full of the collected gas, and then shake it. What happens to the limewater?
Formulating hypotheses.	3. Fill two jars with the same amount of water. Add a teaspoonful of cornstarch to one of the jars. A few drops of tincture of iodine should now be added to each jar. What happens? Test other substances for iodine, e.g., iodized salt, sea foods.
f. The production of carbon dioxide is evidence of oxidation within living things.	
Skills: Formulating hypotheses.	1. Pour limewater into a glass to the height of about one inch. Exhale through a soda straw into the limewater. What happens to the limewater? What does this tell us about the air we exhale? References: C.I.S. T40 S.M.A. T507 S.T.W. T297
Controlling variables, Interpreting data.	2. Seal a potted plant, e.g., geranium and a dish of limewater in transparent plastic. Seal only a dish of limewater in another plastic bag. What do you think will happen? Have children observe their experiment every day. Did anyone notice any difference in their experiment today? What have you learned about a geranium plant? Do you think this is true of all plants?
Interpreting data.	3. Get some mealworms from a pet shop and place them on a piece of paper that is wedged into the top of a vial containing some bromothymol blue solution. Cap the vial. What happened? (Solution turned yellow). Why?
g. The earth's matter is built up of atoms combined in many ways.	
Skills: Experimenting.	1. Collect some common substances, e.g., salt, coal, copper wire, iron ore, sulfur, lead, mica. Examine the substances. What are they made of? References: C.I.S. T42 S.T.W. T190
Formulating models.	2. Using different sized styrofoam spheres and toothpicks construct models of various substances, e.g., water, iron oxide, carbon dioxide.
h. In oxidation, matter is neither gained nor lost.	
Skills: Interpreting, Experimenting.	1. Get two unused flashbulbs of the same size. Balance the flashbulbs on an equal arm balance. Remove one of the flashbulbs gently from the scale, insert it into a camera and snap the shutter. Put the used flashbulb back on the scale. Does the weight of the flashbulb change after it has been used? How can you tell? References: C.I.S. T45 S.M.A. T51 S.T.W. T170
Formulating hypotheses, Interpreting data.	2. Put some moist steel wool into a test tube. Cap the tube tightly. Balance the tube on an equal arm balance. Leave the tube standing on the balance for several days. Is there now more or less substance in the test tube? How do you know?

GRADE V

CONCEPTUAL SCHEME C

Living things are interdependent with one another and with their environment.

SUGGESTED MATERIALS AND EQUIPMENT

water plants (e.g. elodea), glass funnels, test tubes, matches, splints of wood, jars and tops, black paper, alcohol, iodine solution, adhesive tape, microscopes, indicator dye (bromothymol blue or methyl orange), glasses, pieces of cardboard, corks, animal cage, animals (mice, hamsters or guinea pigs), pieces of coal (preferably with plant fossils showing), aluminum foil, cotton, wool, onions, glass slides, cover slips, eyedroppers, toothpicks.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)

S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)

S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

Films	Records
Film Loops	Tapes
Filmstrips	[ ] Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. The capture of radiant energy by green plants is basic to the growth and maintenance of all living things.	Media: *Dependent Plants*, Harper and Row *Photosynthesis*, G-B Instructional *The World of Living Things*, Harper and Row
a. During photosynthesis (the manufacture of carbohydrates), green plants produce oxygen.	
Skills: Formulating hypotheses, Interpreting data, Making operational definitions.	1. Put a bunch of water plants, e.g., elodea, and water into a glass. Cover the plants with an inverted funnel, making sure that the top of the funnel does not extend beyond the surface of the water. Insert a test tube filled with water over the small end of the funnel. Place the whole set-up in a sunny place for a day. What has happened in the test tube? What is the gas that is in the test tube? Any suggestions as to how you can test it? (Insert a glowing splint into the tube). Now, can you explain why we keep green plants in an aquarium? References: C.I.S. T114 S.M.A. T88 S.T.W. T296
Controlling and manipulating variables, Interpreting data.	2. What do you think will happen if you put water into two jars, place a water plant in one jar, and put a snail into both jars. Seal the jars and watch them for a week or two. What happens in each jar Can you explain why?
b. During photosynthesis, green plants manufacture simple sugars and starches, using the energy left.	
Skills: Formulating hypotheses, Making operational definitions.	1. Fold a piece of black paper closely around a geranium leaf and fasten with a paper clip. Cover half of another leaf with black paper. Set the plant in the sunlight for about 3 days. Remove the chlorophyll from the leaves by shaking them in a jar of warm alcohol. Now test the leaves for starch with an iodine solution. How does the iodine show if starch is present? In which of the leaves is there starch? Why is this so? Reference: C.I.S. T116
Formulating hypotheses, Interpreting data.	2. Obtain leaves that are partly green and partly white. Test the leaves for starch, using the same procedure as outlined above. Did any of the white parts turn blue-black from the iodine? Did any of the green portions turn blue-black? How can you explain this?
c. Green plants make carbohydrates from carbon dioxide and water; animals are dependent on green plants for their food.	
Skills: Formulating hypotheses.	1. Make an aquarium in a large jar by sealing in pond water, water plants and sand. Wind adhesive tape around the cap and jar so air cannot get in or out. Place the jar where there is a moderate amount of sunlight. Observe the plants from day to day. Are they growing or dying? Why? Examine the water under a microscope, and maybe this will help us in coming up with a reason. References: C.I.S. T118 S.M.A. T87

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Controlling and manipulating variables, Interpreting data and results.	2. Get three empty jars with self-sealing tops. Put water in all three jars, water plants in two jars, and a good-sized snail in one of the jars with water plants in it. Put a few drops of indicator dye (bromothymo! blue, methyl orange) in each bottle and then seal each jar tightly. Observe for several days. What happens in each of the jars? What does the change of color indicate? Does the snail give off carbon dioxide? Which plant looks healthier?
Formulating hypotheses, Interpreting data and results.	3. Fill two glasses with water. Obtain two pieces of cardboard, make a hole in the middle of each, and then place the cardboards over the glasses. Put the stem of a leaf (e.g., geranium) through the hole in one of the pieces of cardboard. Invert two other glasses over the pieces of cardboard. Aftei a few hours what do you see inside the glass that contains the leaf? Try to explain what the leaf is doing with the water. We might possibly learn something more if we examine a leaf carefully under a microscope.
d. Living things obtain from one another and from the environment the matter and energv they need for growth and activity.	
Skills: Experimenting.	1. Let us try to make a test tube world for one small snail. It will be up to you to decide what should be put in the test tube with the snail. After you have placed what is needed in the tube, seal the tube with a cork, and then select a place to keep your tube. Observe your tube for several days. Were all the snail's needs met? If not, write down what you think is necessary and try to explain why you think it is needed. References: C.I.S. T121 S.M.A. T88
Experimenting.	2. Catch several insects (e.g., grasshoppers) and make a home for them in a glass jar. Put whatever material you think is necessary in the jar. Place the jar in a suitable place and observe for several days. Did your insects have all that they needed in their home? Can you think of ways in which the insects' environment can be improved?
e. Green plants are a basic source for many substances needed by all animal life.	
Skills: Controlling and manipulating variables, Interpreting data and results.	1. Divide a number of hamsters, mice, or guinea pigs into two groups. Design menus, including green plants in one group's menu and no green plants in the other group's menu. Continue the experiment over a period of several weeks. What changes do you notice in each group of animals? Try to explain what has happened.
f. Man, like all other living things, is dependent on his environment — on all the matter and living things in it.	
Skills: Controlling and manipulating variables, Formulating models.	1. You are an astronaut who is going on a trip to the moon. What essential parts of your environment must you take with you if you leave the land environment in a space capsule? References: C.I.S. T125 S.M.A. T295, T315
Formulating hypotheses, Formulating models.	2. A deep sea diver is getting ready to dive into the ocean to a depth of 300 feet. Will the environment in the ocean be different? How is the diver going to prepare himself foi the new environment?
g. Interdependence of living things with their environment is related to the transformation of matter in a chemical change.	
Skills: Formulating hypotheses, Interpreting data.	1. Can you burn stored sunlight? Obtain chunks of coal and examine them carefully. How do we know coal is a fossil plant? How did these fossils capture and store energy? Reference: C.I.S. T126
Formulating hypotheses, Formulating models.	2. What do you think will happen to wood chips if we heat them in a flask? Try the investigation. What does this tell us about the formation of coal?
Interpreting data, Formulating models.	3. Rapidly pump up a playground ball. What happens? Do you think this tells us something about coal and oil formation?

Concepts and Subconcepts	Suggested Activities and Instructional Materials
h. Plant and animal cells change matter as they interchange matter and energy with the environment.	
Skills: Making operational definitions.	1. Line a plate with aluminum foil. First burn a piece of cotton and then a piece of wool in the plate. What difference do you notice in burning wool and burning cotton? How would you explain this difference in odor? What is the substance that is left over after burning? References: C.I.S. T128 S.T.W. T31
Formulating models.	2. Pull a thin layer of onion skin off an onion, place a piece on a slide and stain it with iodine. Look at the slide, under a microscope. Draw a picture of what you see. Now make an epithelial cell slide. Scrape the inside of your cheek with the flat part of a toothpick, smearing the contents on a slide. Stain with iodine. Draw a picture of what you see. In what ways are the onion cell and epithelial cell different? Why is there a difference?

GRADE V

CONCEPTUAL SCHEME D

A living thing is the product of its heredity and environment.

SUGGESTED MATERIALS AND EQUIPMENT

chicken eggs, saucers, flowers, knives, tweezers, hand lens, yeast, erlenmeyer flasks, corks, sugar, tubing, clay, limewater, beakers, microscopes, trays, candles, seeds (e.g., mung seeds germinate quickly), small tubes, slides, cover slips, eye droppers, gelatin, starch, plastic bags, iodine, onions, paper towels, incubator, aluminum foil, feathers, matches, cereal, butter, brown paper, scales, glass squares, 2-quart jars, pipe cleaners, spoons, test tubes, Benedict's solution, lamp chimney, one-holed stoppers, balloons, rubber sheeting, goldfish, cotton, alcohol.

SUPPLEMENTARY REFERENCES

Elementary Science Study. *Teacher's Guide for Small Things.* Scarborough, Ontario: McGraw-Hill Co. of Canada Ltd.

Code for Media:

⧓ Films ⊙ Records
⧓8 Film Loops ●—● Tapes
⊟ Filmstrips [ ] Slides or Transparencies

Code for References:

C.I.S. — *Concepts in Science,* Longmans.
S.M.A. — *Science, A Modern Approach,* Holt, Rinehart.
S.T.W. — *Science for Tomorrow's World,* Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **The cell is the unit of structure and function; a living thing develops from a single cell.** a. Many living things, including humans, begin as a fertilized egg.	
Skills: Observing, Predicting, Formulating models.	1. Crack open a chicken egg into a saucer. Look very carefully at the yolk of the egg. Do you see anything? What do you think the white spot becomes? See if you can find out how the egg cell develops. Reference: S.M.A. T90 S.T.W. T46
Observing, Communicating, Defining terms.	2. Take apart a flower in which the reproductive parts are easily identified, e.g., tiger lily, tulip. Find the sepals, petals, stamens and pistils. Carefully cut open the ovary with a sharp knife. What do you see inside? On which part of the flower do you find the powdery material called pollen? What would happen to the pollen if an insect landed on the flower? When the pollen gets on the pistil what does it do? Media: ⊟ *Plants — How They Live and Grow,* E.B.F. ⊟ *Introduction to Algae,* S.V.E. ⊟ *Health Adventures — Your Bones and Muscles,* Jam Handy ⊟ *Health Adventures — Your Food and Digestion,* Jam Handy, PK-3540 ⊟ *Health Adventures — Your Heart and Lungs,* Jam Handy, PK-1608 ⊟ *Health Adventures — Your Nose and Throat,* Jam Handy, PK-1605 ⊟ *Introduction to the Microscope,* S.V.E. ⊟ *Introduction to Protozoa,* S.V.E.

▶◁ *Microscopic Life: The World of the Invisible,* E.B.F. T-2101

8 mm. Films distributed by Webster Division, McGraw-Hill Book Company:

▶◁$_8$ *Plant Growth Graphing,* LK-64
▶◁$_8$ *Volvox,* LK-58
▶◁$_8$ *Euglena,* LK-66
▶◁$_8$ *Rotifer,* LK-57
▶◁$_8$ *Comparative Sizes of Microscopic Animals,* LK-59
▶◁$_8$ *Paramecium,* LK-65
▶◁$_8$ *Amoeba,* LK-55
▶◁$_8$ *Bean Sprouts,* LK-63
▶◁$_8$ *Budding of Yeast Cells,* LK-56

b. Cells interchange matter and energy with the environment.

Skills: Inferring, Communicating.

1. Place about half a package of yeast into an erlenmeyer flask, and add a warm sugar solution. Insert a cork (loosely) into the flask as soon as possible. What happens? Try to predict why this happened.

Reference: C.I.S. T73

Predicting, Formulating hypotheses.

2. Take two flasks and put half a packet of yeast into each. Place half a glass of warm water in one flask, and half a glass of warm water with dissolved sugar in the other flask. Quickly insert a delivery tube with a clay stopper into each flask. Place the end of each delivery tube in limewater. What changes take place in each flask? Why did one of the beakers of limewater turn milky? Why didn't the other turn milky?

Observing, Formulating models.

3. Let us see what effect sugar has on yeast cells, by observing them under a microscope. What do the yeast cells appear to be doing? Make a drawing of what you see.

c. Energy within a cell comes from a cycle of breaking down and building high energy containing molecules (the cell energy process).

Skills: Observing, Quantifying, Inferring.

1. Using clay, place a birthday candle in a tray of water. Light the candle and then place a test tube over the lighted candle. What things do you "see" happen in the experiment. Why does the candle go out? Why do you think the water rises in the tube?

Reference: C.I.S. T75

Predicting, Formulating hypotheses, Quantifying, Interpreting data and results.

2. Place some germinated mung seeds or other quick-germination seeds in a small tube. Attach this small tube to the inside of a test tube with a piece of clay. Insert the test tube in a tray of water and let it stand for about 24 hours. What happened? Why do you think it happened?

d. Plant and animal cells have basically similar structures.

Skills: Observing, Classifying, Communicating, Formulating models.

1. Examine cells from a plant (e.g., onion) and cells from an animal (e.g., epithelial) under a microscope. What do you see that is the same in both plant and animal cells? Is anything different?

References: C.I.S. T27 S.T.W. T24

Formulating hypotheses, Formulating models, Interpreting data.

2. Mix together a packet of gelatin, a cup of water, and a teaspoon of starch. Pour some of this mixture into a plastic bag. Add a small round ball of clay and then tie the bag tightly. Place the cell model into a weak iodine solution. What happens? How can this be explained?

e. Cells are specialized for different functions.

Skills: Observing, Communicating, Defining terms.

1. Make an onion skin slide, leaf cell slide, and root slide from a sprouted onion bulb. Why is it easy to tell individual cells? How are the leaf cells different from the other onion cells? What job do leaf cells do? What do root cells do for the plant?

References: C.I.S. T80 S.T.W. T31

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Formulating models.	2. Using a razor blade or tweezers, peel off the thinnest possible piece of skin from under a geranium leaf. Place the skin on a glass slide and add a drop of water. What can you see with your microscope? Try to draw what you see.
f. A single-celled organism performs all the life functions within the cell; a many-celled organism is a community of interdependent cells.	
Skills: Communicating.	1. Plan a field trip to pond or ditch for the purpose of collecting pond life. What things are we going to take with us? What are we going to collect? Where should we keep our jars?
	References: C.I.S. T83 S.M.A. T92 S.T.W. T36
Observing, Classifying.	2. Make a slide from a drop of pond water. What do you see? Try to name what you see, using books as a guide.
g. The pattern of the organism is passed along to new cells by duplication of chromosomes and their DNA content.	
Skills: Observing.	1. Isolate one single-celled organism on a slide. Watch the animal carefully. Does anything happen? Why do the two new organisms look like each other?
	References: C.I.S. T85 S.M.A. T85 S.T.W. T29
Communicating, Observing.	2. Study a photograph of DNA molecules magnified with the aid of an election microscope. Of what shape are the molecules? Do they look alike?
h. Growth in a many-celled organism consists in multiplication and differentiation of cells.	
Skills: Experimenting.	1. Plan a field trip to a pond. Before the trip, decide what materials need to be collected to set up aquariums in large jars and discuss where the most likely place to find frogs' eggs would be. Put only about a dozen eggs into each jar aquarium and then cover the jar with a screen. Observe your experiment every day. Keep a record of what you see. Do your records agree with those written in books?
	References: C.I.S. T87 S.T.W. T46
Observing, Quantifying, Interpreting data and results.	2. Lay a double layer of paper towels in the bottom of a deep tray. Lay bean seeds on top of soaked paper towels. Cover the tray. Every day take a bean apart. Draw the steps in the growth of a bean.
Formulating models, Interpreting data and results.	3. Obtain or make an incubator. Into it place about a dozen fertilized chicken eggs. At the end of three days, and every three days thereafter for twenty-one days, remove an egg. Examine its contents. Make notes and draw pictures of what you see.
i. Protoplasm, the living material in the cell, is composed of elements and compounds in the earth's crust and atmosphere. (There is a flow of matter and energy between the organism and the environment.)	
Skills: Observing, Communicating, Formulating models.	1. Crack open a chicken egg and place it in a saucer. Can you point out the nucleus, the cytoplasm, the membrane? Do you think that all the material has a name? (protoplasm).
	References: C.I.S. T89 S.T.W. T49
Defining terms, Interpreting data and results.	2. Let us see if we can find what living material or protoplasm is made of. PROTEINS, MINERALS. — Burn a feather or some hair on a piece of aluminum foil. Did you smell anything? What is left over after the feather has burned? CARBOHYDRATES — Hold a glass plate over burning cereal flakes. What collects on the glass? FATS — Rub some butter on brown paper, and then hold the paper up to the light. How is the place where the butter is at different from the rest of the paper? STARCH — If you put some diluted iodine on a piece of potato, what do you think will happen? Why?

Quantifying, Interpreting data and results.	3. How much water is there in living material? Use a sensitive scale or construct a soda straw balance. Weigh pieces of vegetables or fruits when they are wet; dry them in an oven, and then weigh them when they are dry. Use a chart to make a record of how much the vegetable weighed when it was wet, how much it weighed when it dried, and how much water it contained. Calculate the percentage of water in each example.
j. There is an interchange of matter and energy between the organism and its environment.	
Skills: Observing, Communicating, Inferring, Predicting, Formulating hypotheses.	1. Fill a two-quart or gallon jar with water, cover with a piece of glass, and invert the jar in a tray of water. Remove the glass cover under the water. Insert one end of a tube into the jar. Exhale into the tube until all the water in the jar is displaced. Cover the jar, remove it from the tray, and set it upright. Attach a lighted candle to a pipe cleaner. Lower it into the exhaled air jar. What happens? Relight the candle and lower it into another open jar of the same size. Try to explain why the candle stays lit for awhile. Reference: C.I.S. T98
k. Food substances diffuse through membranes.	
Skills: Formulating hypotheses, Interpreting data.	1. Stir a teaspoonful of starch into a glass of warm water. Why is the mixture cloudy? Fill two test tubes half full with this mixture. Add a teaspoon of saliva from your mouth to one of the test tubes and a teaspoon of warm water to the other test tube. Place both test tubes in a beaker of warm water and let stand for ten minutes. Add a teaspoon of Benedict's solution to each test tube. Observe what happens as the water boils. Benedict's solution changes color when sugar is present. Now, can you explain what happened? References: C.I.S. T100 S.T.W. T80
Formulating hypotheses, Formulating models.	2. Half fill two test tubes with a starch mixture, add saliva to one test tube, and warm water to the other. Attach sausage casing, if at all possible, or wax paper to the ends of each test tube with rubber bands. Stand both test tubes upside down in beakers of warm water. After about two hours remove the test tubes. Add a few drops of Benedict's solution to each beaker. Heat each beaker until the water in the beaker boils for at least 5 minutes. What happens? How do you explain your results? To what in your body may the sausage casing over the test tube be compared?
l. The cell is the unit of structure, and function.	
Skills: Observing, Formulating models	1. Obtain blood, muscle, and other cell tissue from a butcher. Prepare slides and then examine them under a microscope. Draw what you see. In what ways are the cells all alike? What are the differences? Why do you think the cells look so different? References: C.I.S. T101 S.T.W. T37
Communicating, Inferring.	2. Prepare slides of fresh tissues from a freshly dissected frog. Look at the slides under a microscope. Describe what you see.
m. In many-celled organisms, groups of cells and tissues are organized into organ systems, all specialized to perform the body's function.	
Skills: Observing, Communicating, Defining operationally.	DIGESTIVE SYSTEM 1. Dissect a frog, exposing the digestive organs to view. Examine the organs. What happens in the mouth? Where does the food go once it leaves the mouth? Locate the liver, gall bladder, pancreas, small intestine, large intestine. Where is digestion completed? Does digestion take place in the large intestine? How do frog's digestive organs compare to those of a human being? References: C.I.S. T104 S.M.A. T82 S.T.W. T76
Formulating hypotheses, Formulating models.	BREATHING (RESPIRATORY) SYSTEM 1. Make a model of your lungs. You will need a lamp chimney, a one-holed stopper, two plastic feeding tubes, two rubber balloons, and a piece of rubber sheeting. Attach the balloons with rubber bands to the ends of the feeding tubes. Without further instructions try to make a model that shows how you breathe.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing.	CIRCULATORY SYSTEM 1. Let us see if we can see blood flowing in blood vessels of a goldfish. Wrap wet absorbent cotton around the fish, leaving only the tail exposed. Place the tail between two slides. Examine the tail under the low power of a micrscope. What do you see? Are all the blood vessels the same size? In which direction or directions is the blood flowing? Why?
Defining operationally, Formulating models.	2. Obtain a mammal's heart (pig's, cow's) from a butcher. Dissect the heart. Locate the aorta, pulmonary artery, auricles, and ventricles. Where does the blood enter the heart? When the ventricles contract, what happens? How many chambers does a mammal heart have?
Observing, Inferring.	MUSCULAR AND SKELETAL SYSTEMS 1. Feel the upper part of your arm. What is inside your arm? Move your arm up and down. Why are you able to move your arm? Do muscles always have to be attached to the bones?
Formulating hypotheses.	2. Obtain several chicken feet. Store them in water until you are ready to use them. Carefully remove the skin. Now, pull on the tendons and see what happens.
Skills: Communicating.	NERVOUS SYSTEM 1. Spread the ends of a large brass paper fastening about half an inch apart. Close your eyes. Have a classmate touch your fingertips with either the two points or with one point of the fastener without telling you which he is going to do. Do you feel one point or two separate points? Where? Why do you think this is so? Repeat on different parts of the hands, arms and back.
Defining operationally.	EXCRETORY SYSTEM 1. Identify the following excretory organs in a dissected frog: kidneys, bladder. See if you can find out something about how the kidneys take wastes from the body.
Formulating hypotheses.	2. Have one of your classmates dab a piece of cotton soaked in alcohol on your arm. What happens? Repeat the experiment, but use cotton soaked in water. What does this experiment show about perspiration?
n. The structural and behavioral development of a living thing from a fertilized egg is an orderly, predictable process.	References: C.I.S. T87 S.T.W. T46

GRADE V

CONCEPTUAL SCHEME E

Living things are in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

clay, plaster of paris, fossils, aquarium with goldfish, jars or beakers, terrarium, clinical thermometers, laboratory thermometers, wall thermometers, animal cage, animals (e.g., hamsters).

Code for Media:

⋈ Films
⋈8 Film Loops
⊟ Filmstrips
⊙ Records
●—● Tapes
[ ] Slides or Transparencies

Code for References:

C.I.S. — *Concepts in Science*, Longmans.
S.M.A. — *Science, A Modern Approach*, Holt, Rinehart.
S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Living things have changed over the ages.** a. The adaptions of an animal to its environment can be understood by relating bone structure to the functions served.	
Skills: Observing, Inferring, Formulating models, Communicating.	1. Make an imprint of a shell, bone, or a leaf in plasticine, plaster of Paris or clay. Imagine you are a scientist. What things can you learn from the imprints you made?

Formulating models.

2. Obtain an entire skeleton of cleaned chicken bones. Try to fit some of the bones together. How did you go about fitting the bones together? When scientists build a skeleton from fossil bones, how do they know which bones fit together?

References: C.I.S. T156 S.T.W. T337

Media:
- *Stories that Fossils Tell,* S.V.E. PK-3487
- *Up Through the Coal Age,* S.V.E. PK-3486
- *The Coming of the Reptiles,* E.B.F. PK-3891
- *Discovering Fossils,* E.B.F. PK-3038
- *The Age of Mammals,* Life

b. Structural adaptations to environments of the past occurred slowly.

Skills: Observing, Communicating, Formulating models.

1. Obtain pictures that show how some organism, e.g., horse, has changed with time. Make tiny models in clay to show how one part has changed through the ages. Choose either the foot, the whole skull or just the jaw and teeth. Why do you think the horse has changed over the years? In what ways did the horse change? How long did it take for these changes to take place?

References: C.I.S. T157 S.T.W. T345

c. The single-celled organisms that developed in the early seas gave rise to the many-celled organisms of later eras; adaptation to the environment produced more complex structures.

Skills: Observing, Formulating models.

1. If fossils are available to you at the school or at a museum:
   - Examine some one-celled organisms, Protozoa-Trilicites, Camerina.
   - Trace the development of some invertebrates through fossil study, e.g., snails, clams.
   - Take a close look at invertebrates of today by examining recent fossils. The fossils that are most easy to obtain are clams, starfish, sand dollars, snails. Make sketches of what you see.

Observing, Communicating.

2. Which animals are most abundant in water today? Why? Observe a goldfish carefully and you may be able to see why a fish is so well adapted. What special structure has a fish got for taking oxygen out of water? How does it move in water? How does it get its food?

References: C.I.S. T160 S.M.A. T83 S.T.W. T335

d. Gradual changes of structure in water animals of the ancient seas adapted them for land living.

Skills: Quantifying, Interpreting data, Inferring, Controlling and manipulating variables.

1. Place two thermometers, one of which is in a jar of water, on a shelf or in a cupboard. Leave them there until they have reached the same temperature. Now put the thermometer-in-water and the thermometer-in-air in the sunlight or over a hot radiator for about three minutes. Which thermometer shows the greatest change in temperature? Repeat the experiment. This time place the thermometers in a refrigerator or outside. What happens? Is water a safer shelter than the land? Why?

Observing, Communicating.

2. Observe fish in an aquarium and frogs in a terrarium. How is a frog different from a fish? Why is a frog able to live on land?

References: C.I.S. T162 S.M.A. T23 S.T.W. T63

e. The mammals have been more successful in their adaptions than have other forms of living things.

Skills: Quantifying, Interpreting data, Communicating.

1. Take the temperature of your classroom with an ordinary thermometer. If you have a pet reptile available, obtain an oral temperature reading with a laboratory thermometer. Now take your own temperature with a clinical thermometer. Take these temperatures once a day for a week, and record them. Look at your results. Compare the room temperature, reptiles temperature, and your temperature. Can you explain what you have learned?

References: C.I.S. T165 S.M.A. T80

Observing, Communicating.

2. Observe a mammal, e.g., cat, dog, hamster, with a litter of young. How does the mother take care of her young? Does she provide them with food? Why do the young hide under their mother?

GRADE V

CONCEPTUAL SCHEME F

The universe is in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

nails, different kinds of soil, jars with lids, golf ball, toothpaste, balloons, clay, string, plastic bags, pans, air pump, flasks, glass tubing, stoppers, food coloring, funnels, modelling clay, mineral samples, salt, test tube, stand, alcohol lamps, microscopes, microscopic slides, eye droppers, rock specimens (igneous, sedimentary, metamorphic), curved mirrors, flat mirrors, cameras, flexible tubing, prisms, flashlights, light meter, colored paper (black-white-gray), cardboard tubing, diffraction grating, paper clips, baking soda, chalk, salt, copper sulfate, strontium chloride, rubber ball.

Code for Media:

⋈	Films	⊙	Records
⋈8	Film Loops	●_●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Code for References:

C.I.S. — *Concepts in Science*, Longmans.
S.M.A. — *Science, A Modern Approach*, Holt, Rinehart.
S.T.W. — *Science for Tomorrow's World*, Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. Bodies in space, as well as their matter and energy, are in constant change.	
a. Weathering and erosion break down the hardiest rocks.	
Skills: Observing, Interpreting data, Formulating, hypotheses.	1. Place a number of new iron nails on an outside ledge of the classroom window. Look at them every two days for two weeks. Keep a record of what happens. Why did the nails rust? If you left the nails for a long time, what would happen? Reference: C.I.S. T6
Formulating models, Communicating.	2. Construct a model mountain of different kinds of soils, e.g., loam, sand, clay, on your schoolyard. Insert a square of sod into one side of the model. Then, sprinkle the "mountain" with water. Which soil particles move first? Which last? How does the steepness of slope effect the movement of water? How can we slow effects of the running water?
Experimenting.	3. Can growing seeds or plants force rocks or other things apart? Plan an investigation to find out. Keep a record of what happens. Media: ⊟ *Work of Internal Forces*, S.V.E. ⊟ *Our Earth in Motion*, Jam Handy ⊟ *Volcanoes and Earthquakes*, S.V.E. ⊟ *Mountains*, S.V.E. ⊟ *The Story of the Mountains*, E.B.F. ⊟ *Our Earth, Land, Water and Air*, S.V.E. ⊟ *Story of Rivers*, E.B.F. ⊟ *Changing the Face of the Earth*, S.V.E. ⊟ *Light and How it Travels*, Jam Handy ⊟ *Work of Ground Water*, S.V.E. ⊟ *The Earth's Diary*, S.V.E. ⊟ *Pictures in the Sky*, S.V.E. ⊟ *Light and Color*, E.B.F.
b. Weathering and erosion help build up new land.	
Skills: Predicting, Inferring.	1. Fill a jar half full of soil, pebbles, gravel and sand. Add water to within one inch of the top of the two-quart jar. Seal the jar and then shake it thoroughly. Let it stand. How does the sediment settle? Why did it settle in layers? Test your explanation by trying the investigation again. Reference: C.I.S. T8
Skills: Observing, Communicating, Formulating hypotheses.	2. Plan a field trip to an excavation or an eroded river bank area. Look at and carefully examine the layers. What do these layers tell you? What are they made of? How were they likely formed? What is the difference between upper and lower layers of sediment.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
c. The Earth is in constant change.	
Skills: Formulating models, Inferring, Making operational definitions.	1. Cut a baseball or golf ball in half. What do you see inside the ball? Let us see if we can compare this golf ball to the earth we live on. Construct a model of the earth from a tube of toothpaste, a balloon, clay, and a piece of string. Reference: C.I.S. T10
Predicting, Inferring.	2. Spread a plastic bag on the bottom of a pan, letting the open end hang over one end. Cover the bag with a layer of damp sand and tap it down smooth. Set a few objects on the soil to represent buildings and other objects on the earth's surface. Inflate the bag. What happens? How does this model compare to what actually happens to the earth? Reference: C.I.S. 10
d. Heat and pressure generated within the earth result in changes of its surface.	
Skills: Formulating hypotheses.	1. Put colored water into a flask. Insert a glass tube and stopper into the flask. When the flask was heated, what happened to the liquid in the tube? Why? What does this model tell us about an erupting volcano? Reference: C.I.S. T13
Observing, Inferring.	2. Fill a plastic bag with a clay soil and water mixture. Tie the bag to the mouth of a funnel, invert the funnel, and press on the bag. Why does the mixture come out of the bag? Does this happen in a volcano?
e. Pressures on and within the earth uplift the earth's crust.	
Skills: Formulating models.	1. Obtain four or five different colors of modelling clay. Form the clay into layers and then stick them together. Press against the layers from both sides. On another model press against the layers from only one side. Where a mountain rises, slice down the height of it to see the inside. Draw pictures of the mountains. How do you explain what happened? Why are fossils sometimes found on mountainsides. Reference: C.I.S. T16
Skills: Predicting, Communicating.	2. Partially inflate a plastic bag. Tie it. Cut a model of clay layers in half and lay them on top of the plastic bag. Place a weight on one section of the layers. What happens? Why?
f. The composition of the earth's rocks is determined by the manner in which they were formed.	
Skills: Communicating, Interpreting data, Observing.	1. Obtain locally, if possible, a set of samples of the common minerals — mica, feldspar, calcite, hornblende, sugate, olvine, quartz, talc, fluorite, apatites. You should learn to use the characteristics of color, hardness, lustre, and shape of crystals to help you to identify the numbered samples of minerals. Your fingernails (2), a penny (3.5), a pocket knife, and a steel file (6) will be useful in helping you determine the hardness of each mineral. A magnifying glass will be very useful for looking closely at the crystals. A bottle of vinegar will come in handy when you are looking for calcite. Keep a record of what you learn about each mineral. References: C.I.S. T18 S.M.A. T29 S.T.W. T181
Observing, Formulating models.	2. Make a saturated salt solution by dissolving as much salt as possible in boiling water. Place a drop of the hot solution on a microscope slide and observe under a microscope. What happens? Why do you have some small crystals and some large crystals?
Observing, Communicating. Interpreting data, Classifying.	3. Working in groups, try to identify the numbered specimens of igneous rocks. Pictures and written descriptions of these rocks may be a help to you. Make a record of the rock number, minerals found in the sample, and the name you think the rock should have. During the next few days, have the children look at samples of igneous, sedimentary and metamorphic rocks. Once the children have examined these rocks, have them make a comparison of the three groups.
g. The component bodies of the universe are in constant motion.	1. Large telescopes astronomers use have curved mirrors in them. Let us see if we can figure out why. Obtain a curved and a flat mirror. Shine light from a flashlight on each mirror and then move a sheet of white paper in front of the mirror to catch the reflection. Try to draw a diagram to show what happens. Reference: C.I.S. T137 S.M.A. T65

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Interpreting data, Inferring.	2. Do stars move or stand still? Place a camera on a tripod or other sturdy support. Adjust the camera so that it is facing in the direction of the North Star. Lock the shutter in the "open" position and leave the camera undisturbed for three or four hours. Then close the shutter and remove the camera. Develop the film. Why do the stars show up as streaks instead of as pinpoints of light? What must astronomers do to a telescope to get a sharp picture of a star rather than a streak picture? Why must they do this?
h. Light travels in straight lines; it can be broken into a spectrum of colors as it passes through a prism.	
Skills: Predicting, Inferring.	1. Hold a hose or some other flexible tube straight and look at some object. Can you see the object? Now bend the hose and look at the object. What happens? Why can't you see the object if the hose is bent? What do these activities tell you about light? Reference: C.I.S. T39
Communicating, Formulating models.	2. Stand a book on end in the sunlight so that it casts a shadow. Place a sheet of white paper in the shadow. Now hold a prism just above the book. What happens? Can you name the colors? While you hold the prism steady, have a partner outline and label the colors with a pencil. What color is the light entering the prism? What does the prism do to sunlight? See if you can change the order of the colors.
i. The behavior of light may be explained as the motion of waves through space.	
Skills: Observing, Formulating hypotheses.	1. Fill a basin with colored water. Dip differently shaped objects into the water. What do you see? Is there any difference if you dip the objects quickly instead of slowly? Reference: C.I.S. T142
Quantifying, Interpreting data.	2. There is a theory that light travels in waves. See if you can find out from your reference books how short a wave length of light is. When you have found this out, take the color spectrum band you drew in the experiment with the prism and add wave lengths to it. Before you do this, the group should discuss what scale should be used.
j. Light behaves at times as particles and at times as waves.	
Skills: Communicating, Formulating hypotheses.	1. After covering a table with place paper, get three shades of drawing paper (all the same size — black, white, and gray). Place each sheet one at a time on the table and then shine a strong flashlight straight down on the paper. Darken the room. Hold a light meter six inches away from the paper. Watch what happens to the light meter. Why does the meter show different readings each time? Try to explain how you think a light meter works. Now read your reference books to see if your theory and the scientists' theories agree. Do you think light can travel both as waves and as particles? Explain. Reference: C.I.S. T143
k. The light from the stars enables us to determine their composition and their temperature.	
Skills: Observing, Interpreting data, Inferring.	1. Find out how to construct a spectroscope from a piece of black paper, a cardboard tube, and a piece of diffraction grating, or purchase a spectroscope. Straighten a paper clip and make a small loop at one end. Dip the loop in different substances, e.g., baking soda, chalk dust, sodium chloride (salt), copper sulfate, strontium chloride powders. Hold each substance over an alcohol lamp or propane torch flame and then look at the flame through your spectroscope. What do you see? Record the name of the substance and the color of the flame. See if you can figure out how a spectroscope is used in studying the sun and other stars. Can you explain why men must visit the moon or Mars, but not the sun in order to know which elements they are made of? References: C.I.S. T145 S.M.A. T67

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Predicting, Communicating, Inferring.	2. Use a pair of pliers to hold an iron nail in a propane torch or bunsen burner flame. Observe and note what happens to the color of the nail as it gets hotter. How can astronomers use this idea?
I. Distances in space can be measured accurately by using the speed of light as a yardstick.	
Skills: Observing (sense of hearing), Communicating.	1. Bounce a rubber ball against a near wall, against a far wall. Without measuring the distance, how could you tell which wall was further away? Is there any other method you can use to tell how far an object is away from you?
	References: C.I.S. T148 S.M.A. T63
Observing, Formulating hypotheses.	2. Take a flashlight and try to find a mirror in a dark room. How do you find it? How do you know you have found it? Find a second mirror in the room. Can you tell which mirror is farther away? Why? Then would light energy be a good thing to use for measuring distances? What do scientists use? Use your reference books and see if you can find out.

GRADE VI

CONCEPTUAL SCHEME A

When energy changes from one form to another, the total amount of energy remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

blocks, spring balance, support, string, weights, pulley, block and tackle, chisel, wedge, screwdriver, nuts and bolts, screws, meat grinder, charts showing machines, eggbeater, sandpaper, wax paper, aluminum foil, machine oil, empty can, miniature 4 wheel cart, alcohol lamp, balloon, test tube, stopper, container (water), 2 apples, ping-pong balls, funnel, plastic bag, glass rods, ebony rods, compass, silk, cat's fur, model of an atom and molecule, magnet (strong and weak), coils (insulated wire), galvonometer, plastic tube, dry cell battery, bulb and socket, model of a motor, charts on electricity, equipment to make a bell and motor, telegraph model, telephone model, iron filings, tuning forks.

SUPPLEMENTARY REFERENCES

Machines, Life — Time, p. 172-179.
A Source Book for Eelementary Science, p. 373-393.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⋈	Films	⊙	Records
$\bowtie_8$	Film Loops	●—●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **The amount of energy obtained from a machine does not exceed the energy put into it.**	Media: ⊟ *Simple Machines,* S.V.E. ⊟ *Levers At Work,* J.H. ⊟ *Pulleys At Work,* J.H. ⊟ *How Levers Help Us,* Filmstrip House ⊟ *How Wheels Help Us,* F.H. ⊟ *How Ropes and Screws Help Us,* F.H. ⊟ *How Wedges Help Us,* F.H.
a. Machines may multiply force, increase speed, or change direction.	
Skills: Experimenting, Quantifying, Observing.	1. Compare effort required to lift a brick, using a spring balance, lever, pulley and inclined plane. Reference: C.I.S. T72
b. A lever is a simple machine that concentrates the effort, force, and load, each at one point; a lever usually multiplies force.	Media: ⊟ *What Makes An Airplane Fly?* J.H. ⊟ *How Do Helicopters Fly,* J.H. ⊟ *How Do Jets Fly,* J.H.
Skills: Observing, Classifying, Quantifying.	1. Use of lever to lift weight. Vary lengths of load arm and effort arm. Compare 1st, 2nd, and 3rd class levers. Reference: C.I.S. T78
c. Pulley systems both change the direction of the force and multiply it.	Media: ⊟ *Rocket Power for Space Travel,* J.H. ⊟ *What is Static Electricity?* J.H. ⊟ *What is Current Electricity?* J.H. ⊟ *How Most Electricity is Produced,* J.H. ⊟ *Producing Small Amounts of Electricity,* J.H.
Skills: Quantifying, Observing, Experimenting.	1. Use various numbers and combinations of pulleys to lift a standard weight. Reference: C.I.S. T81
d. Most machines are combinations or modifications of a few simple machines.	Media: ⊟ *Electromagnets and How They Work,* J.H. ⊟ *How Electricity is Used in The Homes,* J.H. ⊟ *Using Electricity Safely,* J.H. ⊟ *Inclined Planes At Work,* J.H.
Skills: Quantifying, Predicting, Hypothesizing, Observing.	1. Use an inclined plane of varying slopes to help a load. Reference: C.I.S. T83 2. Experiment wilth wheels and axles to discover how they can multiply force, change direction, and increase speed. Reference: C.I.S. T84

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Observing, Classifying, Communicating, Formulating models, Observing.	3. Students can look for simple machines in small motors, toys, and other complex machines. They can use these principles to construct complex machines of their own.
e. Friction increases effort that must be applied and decreases speed (distance).	Media: *The Work of Gears*, S.V.E. *Machines In Action*, S.V.E. *The Work of the Lever*, S.V.E. *The Work of the Wheel and Axle*, S.V.E. *The Work of the Pulley*, S.V.E.
Skills: Observing, Quantifying.	1. Have students rub their hands together, then use water, oil, soap, sandpaper, etc., between their hands.
Quantifying, Predicting, Experimenting.	2. An investigation — Examine the sandpaper with a magnifying glass. Examine the wax paper with a magnifying glass. Trace the energy changes involved in this investigation. References: C.I.S. 181 S.M.A. 89
f. Work is done only when an object is moved through a distance.	Media: *Work and Friction*, J.H. *Elements, Compounds and Mixtures*, S.V.E. *Atoms, Molecules, Ions*, S.V.E. *Understanding Electricity*, J.H. *What is Magnetism*, J.H.
Skills: Observing, Quantifying, Experimenting.	1. An Investigation — Reference: C.I.S. 185 2. Compare effort and distance of a single fixed pulley to that of a block and tackle. 3. Blow through a drinking straw on to a styrofoam ball which is at rest. What happens? If the ball is coming toward you when you blow on it how is its motion altered? It the ball is moving across the table and you blow on it from the side how does it move? Media: *Magnetic Fields*, J.H.
g. The energy of moving molecules of air and water provide a force that can be harnessed to do work.	(16 mm): *Energy and Work*, E.B.F. *What Is Uniform Motion*, E.B.F. *Molecules in Motion*, E.B.F.
Skills: Observing, Quantifying, Formulating models, Experimenting.	1. Demonstration — References: C.I.S. 196 S.T.W. 49 2. An Investigation — Reference: C.I.S. 199 3. Demonstration — Reference: C.I.S. 201
h. Molecules may be given kinetic energy in a chemical change.	
Skills: Observing, Hypothesizing.	1. An Investigation — Reference: C.I.S. 207 2. Lay a metal plate on a tripod stand and heat it. Now wrap the head of a match in heavy silver paper and place it on the metal plate. What energy changes occur? Reference: C.I.S. 207
i. Differences in pressure result in a force acting in the direction of the lower pressure.	
Skills: Observing, Quantifying, Predicting, Experimenting.	1. Blow across the top of a sheet of paper. 2. An Investigation — Reference: C.I.S. 213 3. Spool and straw on cardboard. Reference: C.I.S. 217

Concepts and Subconcepts	Suggested Activities and Instructional Materials
j. An increase in kinetic energy can produce an unbalanced force.	
Skills: Observing, Predicting, Experimenting.	1. Blow up a balloon and let it go. 2. Throw a ball while standing on roller skates. 3. Charge two balloons by rubbing them with wool, and hang them on nylon threads What happens if you bring the balloons together? As you push them together you are using energy. It is stored as electric (potential) energy. When you release the balloons they fly apart (kinetic energy).
k. A transfer of electrons from one object to another gives them potential energy; when the electrons move they have kinetic energy.	
Skills: Observing, Quantifying, Experimenting.	1. Vulcanite and glass rods, and fur and silk demonstrate transfer of electrons.
l. The energy obtained from moving electrons is never greater than the energy put into making the electrons move through the circuit.	
Skills: Observing, Quantifying, Predicting.	1. Make electromagnets. 2. An Investigation — Reference: C.I.S. 237 3. An Investigation — Reference: C.I.S. 239
m. The energy of moving electrons can be used to do work.	
Skills: Formulating models, Experimenting	1. Make electric bells, motors, telegraph, etc.
n. Sound waves may be converted into varying strengths of electric current, transferred through a conductor, and reconverted into sound waves.	
Skills: Interpreting data, Formulating models, Experimenting, Observing.	1. An Investigation — Reference: C.I.S. 259 2. An Investigation — Reference: C.I.S. 263 3. An Investigation — Reference: C.I.S. 265
o. Electric energy can be changed to electromagnetic waves that can carry signals through space at the speed of light.	
Skills: Observing, Inferring.	1. An Investigation — Reference: C.I.S. 269 2. Demonstration — Reference: C.I.S. T127

GRADE VI

CONCEPTUAL SCHEME B

When matter changes from one form to another, the total amount of matter remains unchanged.

SUGGESTED MATERIALS AND EQUIPMENT

sulfur, styrofoam balls, wire, marbles, modelling clay, sugar cubes, toothpicks, shoe box, dominoes, pencils.

SUPPLEMENTARY REFERENCES

Canadian Newstime, Vol. 4, No. 5, March, 1967.
Shaw, *About Atomic Power*, Radlauer, 1967.
Kahn, *The Peaceful Atom*, Prentice-Hall, 1963.
Reuben, *What Is An Atom*, Benefic Press, 1960.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

Code for Media:

⋈	Films	⊙	Records
⋈8	Film Loops	●—●	Tapes
⊟	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **In nuclear reactions a loss of matter is a gain in energy; and the sum of the matter and energy remain unchanged.**	Media: ⊟ *The Atom*, McGraw-Hill ⊟ *Molecules, Atoms, Simple Reactions*, E.B.F ⊟ *The Composition of Atoms*, E.B.F. ⊟ *Atoms and Molecular Weights*, E.B.F. ⊟ *Molecules in Motion*, E.B.F. ⊟ *Atoms, Molecules and Ions*, S.V.E. ⊟ *Atoms and Molecules*, S.V.E.
a. Each different atom consists of particles arranged in its own characteristic structure.	
Skills: Observing, Interpreting data, Experimenting, Formulating models.	1. Research and report on Rutherford, Currie, Bohr and Dalton. References: C.I.S. 286 S.M.A. 6 2. Examine a piece of sulfur and powdered sulfur. 3. Construct models of atoms using styrofoam balls and wire. References: S.M.A. 33 S.T.W. 113
b. When the nucleus of the atom changes, energy is released.	Media: (16 mm): ⋈ *Atomic Energy Inside the Atom*, E.B.F. ⋈ *Evidence for Molecules and Atoms*, E.B.F. ⋈ *Atom Smashers*, E.B.F.
Skills: Formulating models, Experimenting, Communicating	1. Use marbles to make an atomic model, then shoot in another marble to "split" the atom. References: C.I.S. 295 S.M.A. 71 S.T.W. 101 2. Demonstration — Reference: C.I.S. T139 3. Show pictures of a cyclation and of an atomic reaction. Reference: S.M.A. 72 4. Discuss the uses of atomic reactions. Reference: S.M.A. 75 Media: [ ] *The Atom*, K. E. Master Book for Diazo Copies
c. Energy can be released by fission of atomic nuclei; the rate of fission can be controlled.	
Skills: Interpreting data, Formulating models.	1. Demonstration — Reference: C.I.S. 303 2. Report on Chalk River reactor and other such projects. Reference: S.M.A. 75

Concepts and Subconcepts	Suggested Activities and Instructional Materials
	3. Build a model of a nuclear reactor. Reference: C.I.S. 306
d. Nuclear energy can be harnessed to machines to develop other forms of energy to do work. Skills: Communicating, Interpreting data.	1. Report on uses of nuclear energy, e.g., power stations, submarines, medical uses, etc. References: C.I.S. 308 S.M.A. 78 2. How is nuclear energy changed to other forms?

GRADE VI

CONCEPTUAL SCHEME C

Living things are interdependent with one another and with their environment.

SUGGESTED MATERIALS AND EQUIPMENT

styrofoam balls, seeds, gold fish or salamander, several lengths of rope, vacuum bottle, tin can, samples of metals, samples of man made fibers, Petri dishes, cotton swabs, mould, spores, microscopes, gelatin, bouillon cube.

SUPPLEMENTARY REFERENCES

McCullar, Bernice, *How to Study and Why*, Available from: 3328 Lakeside Cres. S. W. Cal. (2 long play records).
A Fleck of Mold, p. 219.
New Worlds, Ginn.

RECOMMENDED REFERENCES

Code: C.I.S. — *Concepts in Science* (Longmans)
S.M.A. — *Science, A Modern Approach* (Holt, Rinehart)
S.T.W. — *Science for Tomorrow's World* (Collier, Macmillan)

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⊟	Filmstrips	[ ]	Slides or Transparencies

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. **Living things are adapted by structure and function to their environment.** a. Behavior may be inborn and involuntary.	Media: ⊟ *Atoms, Molecules, Ions* ⊟ *Behavior of Living Things*, Y.A.F. ⊟ *How Heat Causes Expansion*, J.H. ⊟ *Gregor Mendel*, E.B.F. ⊟ *Work of Louis Pasteur*, F.O.M. ⊟ *The Salk Vaccine*, P.S.P.
Skills: Experimenting, Observing, Predicting.	1. Gently throw crumpled paper or styrofoam balls at the eyes of a person who is protected by a pane of glass. Did he learn to blink or was it an involuntary action? Reference: C.I.S. T7 2. Plant seeds upside down to see what happens.
b. Behavior consists of responses to changes (stimuli) in the environment.	Media: (16 mm): ⋈ *Antibiotics*, E.B.F.
Skills: Investigating, Predicting, Inferring, Experimenting.	1. An Investigation — What is the stimulus? What is the response? Reference: C.I.S. 13 2. Train a fish, salamander, etc., to respond to a stimulus by using a reward system. How long does the response continue if the reward is discontinued? Reference: C.I.S. T9 3. Library research and report on Pavlov's experiments.
c. Habits and learning result from interaction of inherited structures with stimuli.	Media: ⊙ *How to Study and Why*, Bernice McCullar. Available from: 3328 Lakeside Cres. S.W., Calgary, Alberta.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Observing, Communicating, Hypothesizing, Predicting.	1. Teach students to tie a bowline knot. Do this several times and compare how long it takes each time. It becomes a learned automatic act. Reference: C.I.S. T11 2. Plan the steps one must go through to learn to ride a bicycle. 3. Students develop their own investigation to show good-insight learning. Reference: C.I.S. T14
d. Learning is improved by the development of efficient habits of study.	
Skills: Inferring, Predicting, Hypothesizing, Experimenting.	1. Show how regular practice can aid in fixing a habit by dividing the group into two sections, one section writes each day for a given time with the left hand; the second practices only twice; compare the results after a given length of time. Reference: S.T.W. 329
e. Substances (minerals) in the earth's crust can be altered to produce new materials.	
Skills: Observing, Classifying, Communicating, Predicting, Interpreting data.	1. Demonstrate the difference between a chemical and a physical change in an element. Reference: C.I.S T25 2. An Investigation — Predict how Hall was able to get aluminum. Reference: C.I.S. 50 3. Report on processing aluminum and uses of aluminum. Reference: C.I.S. T24
f. Knowledge of the nature of heat has enabled man to develop new ways to modify and control his environment.	
Skills: Observing, Predicting, Hypothesizing.	1. Have cold and hot water; add a couple of drops of ink to both containers. Watch it swirl around. Compare containers. Time taken to completely mix. Reference: S.M.A. 31 2. Examine a vacuum bottle. How does it keep things hot? How does it keep things cold? Reference: C.I.S. T33 3. From experiments and reading develop several concepts about heat and display in a chart form. Decide how these concepts apply to everyday situations. Reference: S.T.W. 49
g. Metals can be separated from their compounds; they can be combined to obtain new compounds having new properties.	
Skills: Communicating, Observing, Experimenting, Investigating.	1. Discuss how early man lived and how metals were used for tools. 2. Discuss a hypothetical situation to bring out whether the tool or the concept came first. 3. Scratch a tin can; let it rust. Develop ideas about how to prevent rust. 4. Examine different metals to discover their properties. How can alloys be made? What are the uses of alloys? Reference: S.M.A. 11
h. Knowledge of molecular structure enables man to invent new fibers with improved properties.	

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Investigating, Communicating, Interpreting data.	1. Student reports on the silkworm. Reference: C.I.S. T35 2. Discuss how man has tried to imitate this process. 3. Set up a display of samples of various man-made fibres. 4. What are the special properties of these fibres?
i. Bacteria, plants without chlorophyll, depend on other organisms for their food.	
Skills: Hypothesizing, Observing, Experimenting, Investigating.	1. An investigation — setting up bacteria cultures. What conditions favor the growth of bacteria? References: C.I.S. 101, T45 2. Prepare cultures with swabs from cheek, glasses, hair, fingernails, desk, etc. Bacteria are everywhere. 3. Library research on kinds of bacteria.
j. Non-green plants without chlorophyll depend on other organisms for their food.	
Skills: Investigating, Observing, Classifying.	1. Grow bread mould. Examine under a microscope. References: C.I.S. 105 S.T.W 181 2. Plant spores from bread mould on proper culture and in Petri dish of water. Compare growth. 3. Examine different kinds of bacteria with a microscope. Reference: S.M.A. 175
k. Organisms are structurally adapted for defence against hostile micro-organisms in their environment.	
Skills: Communicating, Observing, Hypothesizing, Investigating.	1. Discuss the kind of cells that line the nose and throat. How are they important? 2. An Investigation — Reference: C.I.S. 112 3. Library research on importance of white blood cells.
l. Micro-organisms interact with other living things and their environment. Man changes the environment of micro-organisms as he seeks to conquer disease.	
Skills: Experimenting, Observing, Interpreting data.	1. Research on work of Sir Alexander Fleming. Story — *A Fleck of Mold.* Reference: S.M.A. 174 2. Transfer some mould and some bacteria to a dish. Observe the results. 3. Research on antibiotics. What do they do? 4. Research on work of Louis Pasteur. Reference: S.M.A. 233.
m. Viruses interact with other living things and their environment. Man changes the environment of viruses in seeking to conquer disease.	
Skills: Communicating, Interpreting data.	1. Discussion about common children's diseases. Reference: C.I.S. 196

2. Reports on causes of these diseases.
3. Consult local Health Department for resource speaker.

n. Modern technology uses concepts of science to free the environment of harmful micro-organisms.

Skills: Formulating models, Investigating, Experimenting, Observing.

1. Set up model filtration plant.
2. Bulletin board display on how we attempt to keep our environment free of harmful micro-organisms.
3. Show chemical method of purifying water by adding a drop of bleach to a glass of pond water. Note the decrease of micro-organisms.

GRADE VI

CONCEPTUAL SCHEMES D AND E

The characteristics of a living thing are laid down in a genetic code.

SUGGESTED MATERIALS AND EQUIPMENT

microscopes, prepared slides of cells in mitosis, fruit flies.

SUPPLEMENTARY REFERENCES

Science Curriculum Improvement Study. *Organisms.* New York: D. C. Heath & Co., 1968.

Code for Media:

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Code for References:

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S.M.A. — *Science, A Modern Approach,* Holt, Rinehart.
S.T.W. — *Science for Tomorrow's World,* Collier-Macmillan.

Concepts and Subconcepts | Suggested Activities and Instructional Materials

1. **The characteristics of a living thing are laid down in a genetic code.**

a. Inherited traits interact with the environment.

Skills: Observing, Experimenting, Predicting, Researching.

1. Do the Investigation on page 326 of C.I.S.
2. Look at a prepared microscope slide of cells in mitosis. Look for the nucleus and chromosomes.
3. Research and report on how potatoes can be grown from two parent plants.

Reference: C.I.S. T157

b. The DNA molecule carried in its parts (genes) the code that determines the inherited traits of an organism.

Skills: Researching, Analyzing.

1. Subconcepts b., c. and d. might be approached by using fruit flies (Drosophila), if these are available. Discuss outward makeup — phenotype, and inward makeup — genotype.
2. Research and report on Mendel's Laws.
3. Class discussion on terms such as: pure, dominant, recessive traits.
4. Research, report and discuss the D.N.A. molecule.

Media: ⊟ *Gregor Mendel,* E.B.F. PK-2210

c. Organisms can be maintained genetically pure for a given trait.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
Skills: Researching, Consulting, Experimenting.	1. What is meant by a pure breed or pure strain? Reference: C.I.S. T163 2. How can one produce pure strains of a plant or animal? 3. Get guest speaker from the Dept. of Agriculture or an Experimental Station. 4. If conditions permit do the Investigation — Reference: C.I.S. T338 5. Research and report on development of purebred dogs for specific uses, e.g., Bloodhound.
d. Genetic traits interact in many ways; the resulting effect may be dominance, recessiveness or blending.	
Skills: Researching, Reporting.	1. What is a hybrid? 2. Research and report on: Seth Wright's experiments with sheep, August Weismann's experiments with mice.

GRADE VI

CONCEPTUAL SCHEME F

The universe is in constant change.

SUGGESTED MATERIALS AND EQUIPMENT

Hoffman apparatus, prism, ground glass, protractors, rulers marked in mm., box of toothpicks, heavy cord, alarm clock.

SUPPLEMENTARY REFERENCES:

Gallant, Roy A. *Exploring the Sun.* Garden City, New York: Doubleday & Co., Inc., 1958.

Johnson, Gaylord. *Planets, Space and Stars.* New York: Harvey House, Inc.

Hone, Joseph Victor. *A Sourcebook for Elementary Science.* New York: Harcourt, Brace and World, Inc.

Kohn, Bernice. *The Peaceful Atom.* Englewood Cliffs, N.J.: Prentice Hall, Inc., 1963.

Nicholson, Chamberlain. *Planets, Stars and Space.* Mankato, Minn.: Creative Educational Society.

Zim, Baker. *Stars.* Racine, Wis.: Golden Press, Inc.

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S.T.W. — *Science for Tomorrow's World,* Collier-Macmillan.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
1. Nuclear reactions produce the radiant energy of the stars, and consequent change.	
a. Nuclear reactions are the source of the sun's energy.	
Skills: Observing, Experimenting, Theorizing.	1. Use a film or filmstrip to show how the sun's energy is released. Reference: C.I.S. T181 2. Do the Investigation. This is a chemical reaction. Reference: C.I.S. p. 367 3. How is energy produced in the sun? Discuss how energy is produced as hydrogen is fused into helium. Reference: C.I.S. p. 370 Media: ⋈ *A Trip to the Planets,* 15 min. E.B.F. ⋈ *Frontiers in Space: Exploring the Universe with Telescopes,* 11 min. E.B.F. ⋈ *Atomic Energy — Inside the Atom,* E.B.F. ⊟ *The Sun and Its Energy,* S.V.E. PK-5251 ⊟ *Molecules, Atoms, and Simple Reactions,* E.B.F. PK-5233 ⊟ *The Composition of Atoms,* E.B.F. PK-5232 ⊟ *The Mount Wilson and Palomar Telescope,* E.B.F.

Concepts and Subconcepts	Suggested Activities and Instructional Materials
b. The heat, temperature and size of a star can be determined by analysis of its light.	
Skills: Researching, Reporting, Formulating models, Experimenting, Measuring.	1. Do library research and report on the spectroscope. 2. Make a model spectroscope. Reference: C.I.S. p. 372 Spectrum can be focused on a piece of ground glass. A 35 mm camera can be used to photograph (time exposures) spectrum of different burning materials. Apparatus must be set up in a dark room. 3. Measure size and distance of object by system described in S.T.W Reference: S.T.W. pp. 164-175 4. Investigation into difference between heat and temperature. Reference: C.I.S. p. 375
c. The Milky Way Galaxy is vast in the number of its stars and the distance between them.	
Skills: Observing, Experimenting, Reporting, Hypothesizing.	1. Show film or filmstrip to motivate further investigation of this subconcept. 2. Do Investigation in C.I.S. to show "sampling" technique. Reference: C.I.S. p. 382 3. Report on meaning of "light year". • How far is the closest star? • What is the diameter of our galaxy? • How long would it take a modern space capsule to get to the closest star?
d Stars are continually changing.	
Skills: Listening, Observing.	1. Lecture presented by the teacher on history of stars and how they change. Reference: C.I.S. T188 2. Visit to a planetarium. 3. Guest lecture from an astronomer.
e. The position of the stars changes in a predictable and orderly way.	
Skills: Experimenting, Theorizing, Observing.	1. Do experiment to show the Doppler effect. References: C.I.S. T191 S.M.A. T291 2. How can this be used to predict motion of the stars? 3. How can light waves be used to give useful information about the motion of stars?

SAFETY IN SCIENCE

All children must develop sensible attitudes in relation to taking safety precautions when working in science. Attitudes determine behavior and cannot be taught as abstractions but must be built from experiences they have. To teach safety is a prime responsibility of the school and through situations that fall within the range of a child's own experience safety attitudes and behaviors should be taught. Simple explanations of what not to do must be reinforced with reasons that children can understand. Since science requires active participation, the teaching of safety practices is essential. The best guide is the use of common sense by children and teachers; the best way to handle accidents is to prevent them.

Handling of Heat Sources

1. The one generally recurrent situation that involves an element of danger is the use of heat sources in the form of open flames. Students should be cautioned about the careful use of burners.
2. A fire extinguisher, a fire blanket, and a first aid kit should be readily available

Handling Animals and Plants

1. Children should bring animals to the classroom only after they have received permission from the teacher.
2. Before a small animal is brought into the classroom for observation, plans should be made for proper habitat and food. The living quarters of animals in the classroom must be kept clean, free from contamination, and secure for the confinement of the animals. Plans should be made for animal care over the weekends and during vacation periods.
3. Acquaint children with the potential dangers involved in handling animals, certain plants, and bacteria.

Handling of Chemicals

Children should be cautioned about smelling, tasting or touching unknown chemicals before they have been told by the teacher that it is permissible.

Handling of Electrical Devices

1. Children should be shown how to insert and remove an electric plug from a socket.
2. At the beginning of investigations that involve electricity tell the children not to experiment with electricity at school or home unless an adult is present.

Handling Glassware

1. Either instruct children quite carefully on how to insert glass tubing into stoppers or do it yourself. (Hands should be kept close together.)
2. Dispose of broken or chipped glassware.

REFERENCE LIST OF ELEMENTARY SCHOOL SCIENCE BOOKS

1. **Primary Student References:**

Adler, Irving and Ruth. *Shadows*. (Reason Why Books). Don Mills, Ontario: John Day Publishers, Longmans Canada Ltd., 1961. Easy grades.

Andrews, Roy Chapman. *In The Days of Dinosaurs*. Rexdale, Ontario: Random House of Canada Ltd. (Gateway), 1959. Easy grades.

Asimov, Isaac. *Satellites in Outer Space*. Rexdale, Ontario: Random House of Canada Ltd. (Gateway), 1960. Easy grades.

Berkley, Ethel. *Big and Little; Up and Down*. Don Mills, Ontario: Saunders of Toronto Ltd., 1960. Grades I-III.

Branley, Franklyn M., and Eleanor K. Vaughan. *Mickey's Magnet*. New York: Thomas Y. Crowell Co., 1956. Kindergarten to Grade III.

Bronson, Wilfred S. *Turtles*. New York: Harcourt, Brace and World Inc., 1945. Grades I-II. Highly Recommended.

Buck, Margaret W. *In Yards and Gardens*. New York: Abingdon Press, 1952. Grades II-IV.

Bulla Clyde R. *A Tree is a Plant*. New York: Thomas Y. Crowell Publishers, 1960. Grade II.

Bulla, Clyde R. *What Makes a Shadow?* New York: Thomas Y. Crowell Co., 1962. Grades II and III.

Collier, Ethel. *Who Goes There in My Garden?* Don Mills, Ontario: Saunders of Toronto Ltd., 1963. Grades II and III.

Conklin, Gladys. *Lucky Ladybugs*. Don Mills, Ontario: Saunders of Toronto Ltd., 1968. Kindergarten to Grade III.

Crosby, Alexander L. *The World of Rockets*. Rexdale, Ontario: Random House of Canada Ltd. (Gateway), 1965. Grades III and IV. Highly Recommended.

Downer, Mary L. *The Flower*. Don Mills, Ontario: Saunders of Toronto Ltd., 1955. Kindergarten to Grade III.

Epstein, Sam and Beryl. *All About Engines and Power*. (All About). Rexdale, Ontario: Random House of Canada Ltd., 1962. Average grades.

Freeman, Mae and Ira. *Fun With Chemistry*. Rexdale, Ontario: Random House of Canada Ltd., 1962. Easy grades. Highly Recommended.

Friskey, Margaret. *The True Book of Birds We Know*. Chicago, Ill.: Children's Press, Inc., 1954. Grades I-III.

Hess, Lilo. *Rabbits in the Meadow*. New York: Thomas Y. Crowell Co., 1963. Grades I and II (if read by teacher); Grades III and IV. Highly Recommended.

Johnson, Ryerson. *Let's Walk Up the Wall*. Don Mills, Ontario: Saunders of Toronto Ltd., 1967. Kindergarten to Grade III. Highly Recommended.

Lewellen, John. *The True Book of the Moon, Sun and Stars*. Chicago, Ill.: Children's Press Inc., 1954. Grades I-III.

May, Charles Paul. *When Animals Change Clothes*. Don Mills, Ontario: Saunders of Toronto Ltd., 1965. Grades II-IV.

Podendorf, Illa. *The True Book of Trees*. Chicago, Ill.: Children's Press Inc., 1954. Grades I-III.

Podendorf, Illa. *The True Book of Weeds and Wild Flowers*. Chicago, Ill.: Children's Press, Inc., 1955. Grades I-III. Recommended.

Schlein, Miriam. *Fast is Not a Ladybug*. Don Mills, Ontario: Saunders of Toronto Ltd., 1953. Grades I-III. Highly Recommended.

Schlein, Miriam. *Shapes*. Don Mills, Ontario: Saunders of Toronto Ltd., 1952. Kindergarten to Grade II.

Schloat, G. Warren. *The Wonderful Egg*. Don Mills, Ontario: Saunders of Toronto Ltd., 1952. Grades I, II, III.

Schneider, Herman and Nina. *How Big is Big?* Don Mills, Ontario: Saunders of Toronto Ltd., 1946. Grades II-IV. Highly Recommended.

Selsam, Millicent E. *All About Eggs*. Don Mills, Ontario: Saunders of Toronto Ltd., 1952. Kindergarten to Grade III.

Selsam, Millicent E. *Play With Plants*. New York: William Morrow & Co., Inc., 1949. Primary grades. Highly Recommended.

Selsam, Millicent. *See Through the Forest*. New York: Harper and Row Publishers, Inc., 1956. Grades II-IV. Hightly Recommended.

Sharp, Elizabeth N. *Simple Machines and How They Work*. Rexdale, Ontario: Random House Inc., 1959. Grades II, III and IV.

Webber, Irma E. *Up Above and Down Below*. Don Mills, Ontario: Saunders of Toronto Ltd., 1943. Kindergarten to Grade III.

Zim, Herbert S. *Frogs and Toads*. New York: William Morrow & Co., Inc., 1950. Grades I-III.

Zim, Herbert S. *Snakes*. New York: William Morrow & Co., Inc., 1949. Grades I-III.

Zim, Herbert S. *The Sun*. New York: William Morrow & Co., Inc., 1953. Primary grades. Highly Recommended.

2. **Primary Teacher References:**

Headstrom, Richard B. *Adventures with a Hand Lens*. Philadelphia, Pa.: J. B. Lippincott Co., 1962. Primary grades.

Hone, Elizabeth. (Edited by Paul F. Brandwein). *Teaching Elementary Science: A Sourcebook for Elementary Science*. New York: Harcourt, Brace and World, Inc., 1962. Primary grades. Highly Recommended.

3. **Intermediate Student References:**

Adler, Irving. *Color in Your Life*. Don Mills, Ontario: Longmans Canada Ltd., 1962. Advanced — Average Grades.

Adler, Irving and Ruth. *Shadows. (Reason Why Books)*. Don Mills, Ontario: Longmans Canada Ltd., 1961. Grades III-V.

Adrian, Mary. *Honeybee Tells Honeybee*. Don Mills, Ontario: Saunders of Toronto Ltd., 1952. Grades III-VI.

Asimov, Isaac. *Breakthroughs in Science*. New York: Houghton Mifflin Co., 1959. Intermediate grades.

Asimov, Isaac. *Realm of Measure*. New York: Houghton Mifflin Co., 1960. Advanced grades.

Billington, Elizabeth. *Understanding Ecology*. Don Mills, Ontario: Saunders of Toronto Ltd., 1968. Grades V and VI.

Branley, Franklyn M. *Mars: Planet Number Four*. Revised Edition. New York: Thomas Y. Crowell Co., 1962. Intermediate Grades. Highly Recommended.

Brown, Stanley and Barbara. *The Story of Dinosaurs and the Age of Reptiles*. New York: Harvey House, Inc., 1958. Average grades.

Buck, Margaret W. *In Ponds and Streams*. New York: Abingdon Press, 1955. Grades III-VI. Highly Recommended.

Buehr, Walter. *Volcano*. New York: William Morrow & Co., Inc., 1962. Intermediate grades. Highly Recommended.

Cooper, Elizabeth K. *Science in Your Own Back Yard*. New York: Harcourt, Brace and World, Inc., 1958. Intermediate grades. Highly Recommended.

Cosgrove, Margaret. *Wonders Under a Microscope*. Toronto: Dodd, Mead & Co. (Canada) Ltd., 1959. Intermediate grades. Highly Recommended.

Doering, Harold, and J. Mary McCormick. *An Ant is Born*. Don Mills, Ontario: Saunders of Toronto Ltd., 1946. Grades IV-VI.

Doering, Harold. *A Bee is Born*. Don Mills, Ontario: Saunders of Toronto Ltd., 1962. Grades IV-VI.

Freeman, Mae and Ira. *Fun and Experiments with Light*. Rexdale, Ontario: Random House of Canada Ltd., 1963. Average grades. Highly Recommended.

Freeman, Mae and Ira. *Fun With Science*. Rexdale, Ontario: Random House of Canada Ltd., 1956. Average grades. Highly Recommended.

Freeman, Mae and Ira. *The Story of the Atom*. Rexdale, Ontario: Random House of Canada Ltd., 1960. Grades III and IV Highly Recommended.

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